MONTHLY NOTICES

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Lieut.-General J. F. TENNANT, R.E., C.I.E., F.R.S., President, in the Chair.

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Joseph Brooks, Trigonometrical Survey of New South Wales, Lands Department, Sydney;
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Rev. Aloysius L. Cortie, S.J., St. Beuno's College, St. Asaph, North Wales;
William Bladen Croft, M.A., 9 College Street, Winchester;
James Gallaher, The Limes, Leyton; and St. George's House, Eastcheap, E.C.;
Rev. H. Grattan Guinness, D.D., F.R.Hist.S., F.R.G.S., Harley House, Bow, E.; and Curbar, *viâ* Sheffield;
Charles W. H. Jeavons, Horseley Place, Tipton, Staffordshire;
John Mitchell, jun., Brockholes, Huddersfield;
William M. Pierson, San Francisco, California, U.S.A.;
James Lidderdale Scott, Shanghai, China;
Arthur Laidlaw Selby, M.A., University College of South Wales and Monmouthshire, Cardiff;
Rev. Walter Sidgreaves, S.J., Director of Stonyhurst College Observatory, Blackburn, Lancashire;
John Peter George Smith, Sweyney Cliff, Coalport, R.S.O., Shropshire;
Arthur John Walker, New College, Oxford; and Bayard's Lodge, Knaresborough, Yorkshire,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended:—

Thomas Richard Clapham, Gentleman, Austwick Hall, near Settle, Yorkshire (proposed by Herbert Sadler);

Arthur Kennedy, Solicitor, 1 Clement's Inn, W.C. (proposed by J. E. Drower).

Fifty-eight presents were announced as having been received since the last meeting, including, among others:

Annals of Harvard College Observatory, vol. xxiv (Results of Observations with the Meridian Photometer, 1882–86); presented by the Observatory.

Annalen der Sternwarte in Leiden, Band V. (containing Zone Observations 29° 50′ to 35° 10′); presented by the Observatory.

Collected Scientific Papers of James Clerk Maxwell, 2 vols.; presented by the Clerk Maxwell Memorial Committee.

MS. Observations of Shooting Stars, 1873–89, by W. F. Denning; presented by the Author.

Bichromate Battery and Ruhmkorff Coil, presented by Mr. J. E. H. Peyton.

Remarks on Mr. Fowler's Note on the Duplicity of α Lyræ.

By Professor H. C. Vogel, Foreign Associate.

In the last number of the *Monthly Notices* (vol. li. p. 8) Professor Lockyer communicated some photographic observations of stellar spectra made at South Kensington by Mr. Fowler, from which the duplicity of *α Lyræ* was concluded. Mr. Fowler would certainly have to be felicitated if at the very outset of his work on photographic spectra he had indeed succeeded in making a discovery of such great interest; but at present, for reasons which I beg to lay before the Society, it seems to me that his conclusions from his observations can scarcely be accepted without independent confirmation.

I think it will be of interest for me to communicate the results of photographic observations of *α Lyræ* made at Potsdam during the years 1888 to 1890.

These observations are:—

1. 1888, September 28.—Exp. 35^m. Many lines, definition very sharp, no trace of double lines.

2. 1888, November 11.—$8^h\ 0^m$, Potsdam mean time. Exp. 60^m. Beautiful photograph, a great number of lines, all lines very sharp; no duplication indicated.

3. 1888, November 13.—$7^h\ 15^m$, Potsdam mean time. Exp. 70^m. An extremely sharp photograph containing a great number of well-defined lines. No double lines.

4. 1889, May 31.—$10^h\ 30^m$, Potsdam mean time. Exp. 60^m. Good photograph, many lines, extremely sharp.

5. 1889, June 6.—$10^h\ 15^m$, Potsdam mean time. Exp. 30^m. Good photograph, many lines, extremely sharp.

6. 1889, September 15.—$10^h\ 5^m$, Potsdam mean time. Exp. 30^m. Good photograph, many lines, very sharp.

7. 1889, November 24.—$6^h\ 40^m$, Potsdam mean time. Exp. 30^m. Good photograph, sharp lines.

8. 1890, November 25.—$5^h\ 58^m$, Potsdam mean time. Exp. 45^m. Good photograph, only few lines visible, but very sharp.

9. 1890, November 25.—$10^h\ 45^m$, Potsdam mean time. Exp. 40^m. Photograph faint. Star near the horizon. Magnesium line (wave-length 448·14 $\mu\mu$) sharp and not doubled.

10. 1890, November 26.—$8^h\ 43^m$, Potsdam mean time. Exp. 45^m. Spectrum not very good on account of the low temperature. Nevertheless lines sufficiently sharp and certainly no trace of duplication.

Mr. Fowler deduces from his observations of α *Lyræ* a relative velocity of the component stars of about 370 miles per second, in a nearly circular orbit, with a period of about 24·68 hours. From these data it is easy to see that, during 23·83 hours, in every revolution of the stars in their orbit the lines must be separated by a distance corresponding to a relative motion of more than 20 miles. I state this as a lower limit, on the supposition that a separation of the lines cannot be seen when the relative motion is less than 20 miles; nevertheless, I am sure that the sharp definition of the lines in the photographs taken with the Potsdam spectrograph would permit a separation due to a very much smaller relative motion to be easily detected.

I beg to draw attention at first to the three Potsdam observations of 1890, which are in direct opposition to Mr. Fowler's results. Suggesting that if at one of these observations the lines were absolutely single, it is to be expected, accepting Mr. Fowler's period, that they would be separated in both the other observations; and especially in the second photograph taken on November 25, after an interval of five hours, nearly a maximum of separation must occur.

On Mr. Fowler's data it would rarely happen for the lines to be seen single, as Mr. Fowler himself points out: "The doubling of the line takes place so quickly that it is difficult to say when it is absolutely single." With a period of 24·68 hours, twice only during that interval for the very short time of 0·43 hours would the lines be narrow enough to appear single on the limit of separation suggested above—that is to say, at a distance corresponding to a relative motion not greater than 20 miles per second.

No calculation is needed to show how exceedingly small is the probability that all the Potsdam observations in 1888 and

1889 happened to be made precisely at the very times of these short minima. But there is another consideration which is even more crucial, arising from the great velocity with which the lines would begin to separate after the moments of complete coincidence. Now the average length of exposure given at Potsdam was 45 minutes. On Mr. Fowler's data, it is clear that it would have been absolutely impossible to have obtained the lines sharply defined with so prolonged an exposure. It is certain that the lines would have come out upon the plates very diffused through a breadth corresponding to a relative motion of about 50 miles; but, on the contrary, all the lines in the photographs of *α Lyræ* are well defined and sharply single.

In the Potsdam spectrograph a small part only of the spectrum is photographed in the neighbourhood of the Hγ-line, from about λ 420 μμ to λ 460 μμ, and consequently the K-line, the duplicity of which Mr. Fowler observed, is not included in our photographs. Though Mr. Fowler says that other fine lines seen in his photographs were also "seen to be double in two or three photographs," yet possibly the objection might be raised that the spectra of the component stars of *α Lyræ* had only the hydrogen lines and K in common. The answer is that no relative displacement of the lines in the superposed spectra of the two component stars has occurred. A measurement of a group of the following lines on all the photographs: 446·88, 448·14 (magnesium-line), 452·30, 453·43, and 454·99 μμ showed no displacement greater than ± 5 miles.

Another objection might be urged in opposition to the evidence from the Potsdam photographs, based on the supposition that the fine lines in the part of the spectrum which they contain are all due to the spectrum of one only of the two component stars. This objection is completely met by the measures of the magnesium-line (448·14 μμ) and of two lines near the Hγ-line (432·62 and 435·22 μμ), which show that no displacement of any importance can be detected relatively to the terrestrial hydrogen-line simultaneously photographed on the plate. If Mr. Fowler's observations were correct, alterations in the positions of these fine lines, even if due to one component star only, should occur, corresponding to velocities up to 185 miles per second. Apart from the measures, which show that no such displacement took place, it is clear that, on this supposition of the motion of one star only showing on the plate, all the lines would be hazy and broad during an exposure prolonged through three-quarters of an hour.

I may add that all the lines in the part of the spectrum which is shown by the Potsdam photographs in the case of *β Aurigæ* are found to double periodically, and it is by no means difficult to measure the duplicity. On 1890, November 25, $9^h\ 43^m$ Potsdam mean time, I measured the separation of some lines in this star, which lines are also present in the spectrum of *α Lyræ*, and determined from them the relative motion of the two components forming the binary star *β Aurigæ*, as follows:—

W.L.	Miles.
448·14	136
449·16	128
450·15	127
453·43	133
454·99	134

I am sorry to have to say that the foregoing observations of *α Lyræ* made at Potsdam cannot be reconciled with Mr. Fowler's observations and the conclusions he draws from them.

It is not for me to suggest the possible causes which have led to the double lines which Mr. Fowler occasionally finds on his photographs of *α Lyræ*. Without great care and a special knowledge of the particular drawbacks to which the arrangement is liable, it is by no means unlikely for photographs taken with prisms over the object-glass to show occasionally a duplication or even a triplication of the lines in the spectrum of a star.

In the case of the Potsdam instrument, in which a slit is used, the possibility of getting double lines which are not due to real motions of the components of a close double star is practically excluded.

I hope Mr. Fowler will allow me to suggest to him to test his instrument and his method of working, by taking, in the first place, photographs of the spectrum of *β Aurigæ*, the motions of which are already known. Further, it would be well if he followed Professor Pickering's example in employing a greater dispersive power. The observations taken at Potsdam are with a dispersion still greater even than that used by Pickering.

I beg, in conclusion, to draw attention to the calculation and to the diagram given in Mr. Fowler's paper, as they fall far short of the accuracy which may be justly looked for in so important a statement. November 1, 8^h may be taken as the time of a zero point, because the following observations of this day show a regular increase in some way, and then calculation shows, with the given period of 24·68 hours, the following results:—

	h	Calculated Motion.	Observation.	C.—O.
Oct. 3	9·00	313 miles.	180 miles.	+133
8	8 00	314 „	370 „	− 56
9	7·00	204 „	232 „	− 28
10	7 33	176 „	260 „	− 84
11	8·50	215 „	218 „	− 3
12	8·25	139 „	294 „	−155
14	10·00	172 „	260 „	− 88
17	10·00	13 „	0 „	+ 13
27	8·00	282 „	109 „	+173
28	6·50	113 „	0 „	+113
Nov. 1	8·00	0 „	0 „	0
1	8·50	47 „	109 „	− 62
1	10·00	180 „	180 „	0
4	9·00	97 „	0 „	+ 97

An alteration of the zero point of ± half an hour, equal to about 50 miles, does not produce any remarkable improvement; and I doubt greatly whether, from a scientific point of view, any reasonable accordance between calculation and observation could in any way be made out.

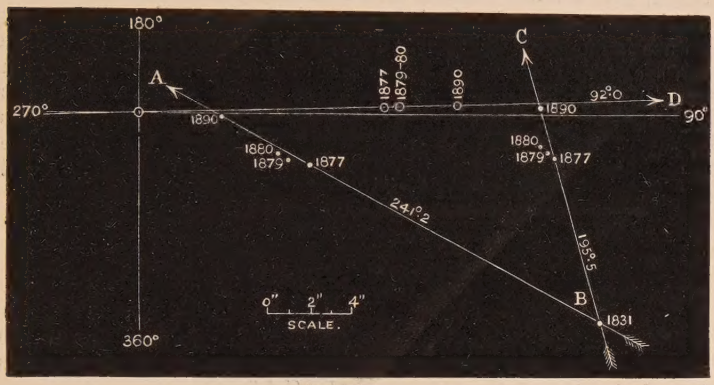
The Proper Motion of H 1968. By S. W. Burnham.

The double star *H* 1968 was first noted by Sir John Herschel with the 20-foot reflector at Slough, and entered in his Fifth Catalogue, published in 1833 (*Memoirs R.A.S.*, vol. vi.) The position-angle was measured and given as 61°·3, the distance being estimated as 20″±, and the magnitudes called 8 and 10–11. Naturally a pair of this class would not attract much attention, and, so far as I know, it was never looked at or referred to by anyone for nearly half a century following. During the several years in which I was using the 6-inch Clark telescope at Chicago, I looked up hundreds of double stars to fix their places by identifying them in some of the star catalogues, to correct various apparent errors in magnitudes, descriptions, &c., and for other purposes, and among others examined the pair in question in December 1875. The apparent change since Herschel's observation, particularly in distance, was very striking, and could not come from any ordinary error in the early description. I called the attention of Baron Dembowski to the probable change which had taken place, and he made a set of measures in 1876 and 1877, which will be found on page 347 of vol. i. of his observations. The name of the star is not given. Subsequently this pair was measured at Cincinnati, and still later by me with the 18½-inch refractor of the Dearborn Observatory. I have lately finished a series of measures at this observatory. So far as I know, these are all the measures that have been made anywhere. They are as follows:—

	°	″				
1831	61·3	20 ±	8	10–11	H	1*n*
1877·23	73·1	8·50	7·1	10·0	De	4*n*
1879·87	71·9	7·46	...	...	Cin	2*n*
1880·09	73·6	6·94	...	...	β	3*n*
1890·86	87·8	3·98	7·5	9 7	β	4*n*

These measures should be sufficient to determine the character of the motion. We have no means of ascertaining the exact time when Herschel measured the angle; but as he states the observations of the stars comprised in his Fifth Catalogue were made in the years 1830 and 1831, I have assumed 1831·0 as the most probable date, and that is near enough for the purposes of this investigation.

This star, according to Argelander, has a proper motion of 0″·356 in the direction of 92°·6; but it has been shown recently (Stumpe, Ast. Nach., No. 2999) that from an error in R.A. in one of the catalogues, this value is too large, and that the annual movement is 0″·252 in the position-angle of 92° 0. Laying down the measures given above, it is apparent that this proper motion entirely fails to account for the motion of the small star, which makes a large angle with the line of the motion of the principal component.



The accompanying diagram shows the several positions of the stars at the dates given. The original diagram was made on a scale of 2″ to one inch, and then photographed down to the size given here. The position-angles were accurately plotted to the tenth of a degree, and the distances to the second decimal place. The positions on the line A B are those of the small star, with the principal star considered fixed at the central point. If the smaller star were really fixed, then of course this line should be parallel with the line D, which is the direction of the proper motion of the other star. One of two things must certainly follow: either this proper motion is erroneous, or the smaller star has a proper motion of its own, for it is evident that no question of orbital motion can arise in this case. The apparent motion of B during the interval of 13·63 years between the measures of 1877 and 1890 is 4″·75, or at the rate of 0″·35 per annum, in the direction of 241°·2. Evidently, if this star is fixed, the proper motion of A given above is wrong, and should be 0″·35, in the direction of 61°·2. This would give some change in declination, instead of placing it substantially all in right ascension. It does not seem probable that so large an error exists in the recognised proper motion.

On the other hand, if the motion of A is sensibly correct, the real motion of B can be easily determined from the positions of that star on the line B C, which are plotted with reference to the

successive places of A along the line D at the several epochs, determined by the annual proper motion of 0″·252. In other words, these places are the actual positions in the heavens of the two stars at the several dates upon the assumption that the larger star has a yearly movement of 0″·252, in the direction of 92°·0. In that case B has an annual motion of 0″·18, in the direction of 195°·5. Both of the lines A and C are drawn through the positions given by the measures of 1877 and 1890, as they are made up of more individual observations, and will, I think, give a more reliable direction than could be derived from all the measures. In the inferences drawn from these measures no use is made of the approximate measures of Herschel, but we can see what the position-angle and distance should have been in 1831 by both assumptions of proper motion. At that time B must have been 24″ distant, in the direction of 65°·5, which is as close an agreement with Herschel's observation as could be expected. The minimum distance between the stars of 1″·8 will be reached about 1901, after which they will slowly separate.

The principal star is *Lalande* 593, and its place (1880) is :—

R. A. $0^h\ 21^m\ 35^s$
Decl. $-\ 17°\ 4'$

The magnitude is variously estimated. In addition to the magnitude given in connection with the measures, it is rated as 8 by Lalande and Gould, and 7·3 by Schönfeld.

Mount Hamilton.
1890 *Dec.* 5.

A Comparison between the Greenwich Lunar Observations, 1887, *and Hansen's Tables uncorrected and corrected for the Change in the Unit of Mean Time introduced in the Year* 1864, *and with Hansen's Tables as modified by Professor Newcomb.* By E. J. Stone, M.A., F.R.S., Radcliffe Observer.

The Appendix to the *Monthly Notices*, vol. l., contains the results of an accurate comparison between the Greenwich Lunar Observations 1847–1861 and Hansen's Tables.

An examination of the residual errors H–O will show that the motion of the Moon was very closely represented by Hansen's Tables during the period 1847–1861. But the separate residuals indicate the existence of sensible, if small, errors in Hansen's Tables due either to defects of theory, or to imperfections in the practical methods of comparing the theoretical and observational results.

The largest residual errors H–O in longitude which I have noticed amongst the results from the meridional observations are :—

1852, Aug. 4 and 7	+ 6″·4	+ 7″·1
1854, Sept. 28 and 29	−13·2	−11·5

There are several negative residuals which are not much less than 10″, and several positive residual errors about 6″. But there are more than 80 of the negative residuals which are not less than 7″, and more than 40 of the positive residuals which are not less than 4″, and, speaking broadly, the residual errors in longitude may be considered to lie between

$$-7''{\cdot}5 \quad \text{and} \quad +4''{\cdot}5$$

The Greenwich Observations 1862–1863 were directly compared with Hansen's Tables, and the results are given in the Greenwich volumes of those years. As no fundamental changes were made in the methods adopted at Greenwich in comparing the tabular and observational results between the years 1847–1863, I have given the mean annual values of H–O in longitude for the years 1847–1863, both inclusive:—

1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855
+0″·51	−0″·53	−1″·08	−0″·97	−1″·93	−1″·57	−2″·18	−2″·34	−1″·40

1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.
−1″·51	−2″·41	−2″·61	−2″·49	−3″·62	−2″·95	−2″·83	−1″·61

The mean error of Hansen's Tables for the period 1847–1863 was therefore

$$-1''{\cdot}854$$

If we apply this correction to the residual errors we obtain

1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.
+2″·36	+1″·32	+0″·77	+0″·88	−0″·08	+0″·28	−0″·33	−0″·49	+0″·45

1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.
+0″·34	−0″·56	−0″·76	−0″·64	−1″·77	−1″·10	−0″·98	+0″·24

These results show that the mean annual values of H–O are subject to small but sensible errors of a periodical character, besides the constant error −1″·85. And it might reasonably have been expected that the errors of Hansen's Tables for many subsequent years would be confined within similar limits to those which existed during the period 1847–1863, and that the mean annual residual errors would oscillate about the mean value −1″·85. But, instead of such being the case, the mean annual residual errors since 1864 have, without a single exception, been positive; and although the effects of small oscillations, of about the same magnitude as those shown during the period 1847–1863, can be clearly seen, they are completely

overshadowed by a regular secular change which has now made the mean annual residual errors of Hansen's Tables larger than the mean error from 1847 to 1863 by more than 18″.

As the Greenwich Lunar Observations have not recently been directly compared with Hansen's Tables, I have thought it desirable to compare them for the year 1887; but, for the purpose of showing the magnitude of the secular changes since the mean interval 1847–1863, and of drawing attention to the magnitude of the modifications of Hansen's Tabular Results, introduced by Professor Newcomb's corrections, and as corrected for the change of the variable, t, which I consider necessarily resulted from changes introduced in 1864, I have increased Hansen's residuals by the mean error 1″·85 which existed during the period 1847–1863.

This is absolutely necessary before comparing the effects of Professor Newcomb's corrections and mine. Professor Newcomb, from a direct discussion of recent observations after the change of the residual errors of Hansen's Tables had become well marked and recognised, altered the *epoch*, mean motion of the Moon relatively to the apse, and the long inequalities which enter into the fundamental argument of Hansen's Tables so that the mean residual error in longitude about 1875 became insensible; the rate of change per unit of time, agreed with the recent observations; and the earlier observations were approximately represented by an empirical modification of the long inequalities. But an alteration of t after 1864 to bring it back to its scale before 1864, if properly made, would simply leave the residual errors of Hansen's Tables after 1864 of the same magnitude and subject to the same periodical fluctuations as those which existed 1847–1863.

I may mention that I selected the year 1887 as the latest year available, but that I have recently received a copy of the Greenwich volume for 1888. I have examined the results sufficiently to say that, had this volume been available, a comparison between the residual errors as corrected by Professor Newcomb and those which directly result from my views of the alteration of t would have been slightly more favourable than the results here given. But practically the corrected results are sensibly identical, as they should be if the cause I have indicated is the real cause of the *per saltum* change in the errors of Hansen's Tables, for I, if my views are right, have altered back the new t to its former value; and Professor Newcomb, accepting the new t, alters the epoch and mean motion per unit of time to suit the variable t.

The Table of Errors of Longitude and E.N.P.D.

Day, 1887.		Errors of Longitude. Hansen *minus* Observed.			Errors of Ecliptic P.D. Hansen *minus* Observed.		
		Uncorrected for the Change of t made in 1864, but Corrected for the Mean Error of the Tables 1847 to 1863.	Corrected by Newcomb.	Corrected for the Change of t made in 1864, and for the Mean Error of the Tables 1847 to 1863.	Uncorrected for the Change of t made in 1864.	Corrected by Newcomb.	Corrected for the Change of t made in 1864.
		"	'	"	"	"	"
Jan.	1	+ 9·52	− 5·79	− 7·32	+ 5·37	+ 4·29	+ 4·13
	4	+ 15·60	− 1·06	− 2·31	+ 3·23	+ 2·75	+ 2·69
	5	+ 12·34	− 4·40	− 6·18	+ 1·50	+ 1·26	+ 1·29
	6	+ 14·71	− 2·84	− 4·36	− 1·61	− 1·40	− 1·37
	10	+ 17·19	− 1·73	− 3·67	− 1·94	− 0·42	− 0·18
	12	+ 19·95	+ 1·09	− 0·92	− 5·25	− 3·64	− 3·36
	16	+ 21·29	+ 3·50	+ 1·66	− 0·34	+ 0·08	+ 0·36
	30	+ 16·95	+ 1·20	− 0·11	+ 0·58	− 0·17	− 0·34
Feb.	1	+ 15·24	− 1·25	− 2·61	− 1·26	− 1·52	− 1·56
	4	+ 13·69	− 4·12	− 5·98	− 1·50	− 0·70	− 0·58
	6	+ 17·50	− 1·41	− 3·43	− 1·11	+ 0·25	+ 0·54
	7	+ 17·78	− 1·54	− 3·49	− 2·16	− 0·61	− 0·25
	15	+ 22·85	+ 5·60	+ 4·11	+ 2·18	+ 1·87	+ 1·80
	27	+ 14·93	− 1·16	− 2·29	+ 0·36	− 0·31	− 0·41
	28	+ 13·65	− 2·49	− 3·73	− 1·54	− 1·97	− 1·96
Mar.	1	+ 11·76	− 4·63	− 6·10	− 1·19	− 1·35	− 1·31
	2	+ 14·12	− 2·67	− 4·20	+ 0·99	+ 1·20	+ 1·29
	3	+ 14·78	− 2·43	− 4·02	− 2·96	− 2·28	− 2·31
	6	+ 13·79	− 5·27	− 7·04	− 2·51	− 1·01	− 0·73
	10	+ 22·10	+ 2·14	+ 0·31	− 2·04	− 0·74	− 0·54
	12	+ 19·46	+ 0·56	− 1·46	− 2·14	− 1·58	− 1·49
	13	+ 23·16	+ 4·71	+ 2·94	+ 0·55	+ 0·68	+ 0·71
	16	+ 21·30	+ 4·55	+ 3·00	− 3·58	− 4·27	− 4·57
Apr.	2	+ 14·40	− 3·50	− 5·36	+ 0·18	+ 1·40	+ 1·74
	3	+ 14·04	− 4·27	− 6·26	− 2·11	− 0·69	− 0·41
	4	+ 14·86	− 4·52	− 6·14	− 1·98	− 0·41	− 0·08
	7	+ 18·30	− 1·48	− 3·61	− 3·47	− 2·36	− 2·14
	8	+ 19·59	+ 0·20	− 2·04	− 2·34	− 1·6	− 1·47
	10	+ 21·11	+ 2·54	+ 0·64	− 2·11	− 2·07	− 2·25
	11	+ 22·77	+ 4·57	+ 2·96	+ 2·87	+ 2·37	+ 2·32

Day, 1887.		Errors of Longitude. Hansen *minus* Observed. Uncorrected for the Change of t made in 1864, but corrected for the Mean Error of the Tables 1847 to 1863.	Corrected by Newcomb.	Corrected for the Change of t made in 1864, and for the Mean Error of the Tables 1847 to 1863.	Errors of Ecliptic P.D. Hansen *minus* Observed. Uncorrected for the Change of t made in 1864.	Corrected by Newcomb.	Corrected for the Change of t made in 1864.
		″	″	″	″	″	″
May	3	+14·07	−5·29	−7·02	−1·47	−0·21	+0·18
	5	+17·94	−1·69	−3·61	−0·54	+0·22	+0·48
	7	+18·97	−0·38	−2·16	−2·71	−2·68	−2·69
	8	+18·89	−0·20	−1·73	−1·93	−2·19	−2·35
	9	+20·08	+1·67	+0·08	−0·28	−0·80	−1·11
	12	+20·79	+4·03	+2·74	+1·46	+0·36	−0·04
	14	+21·15	+4·99	+3·88	+1·91	+0·46	+0·41
	26	+15·62	−2·10	−3·77	−3·74	−2·77	−2·32
	30	+13·97	−4·74	−6·51	−0·38	+1·01	+1·26
	31	+15·34	−3·30	−5·50	−2·52	−1·56	−1·07
June	5	+18·42	−0·15	−1·94	−1·09	−1·43	−1·83
	6	+20·00	+1·70	+0·15	+0·24	−0·84	−0·84
	8	+19·61	+2·49	+0·90	+3·40	+2·09	+1·85
	9	+20·66	+3·94	+2·44	+1·09	−0·22	−0·52
	11	+20·01	+4·16	+2·67	+3·06	+1·92	+1·53
	12	+17·16	+1·04	−0·09	+2·12	+0·97	+0·73
	13	+20·87	+4·96	+3·67	+1·12	+0·27	−0·04
	14	+17·28	+1·29	+0·05	+2·09	+1·20	+1·18
	25	+19·07	+0·62	−1·29	−6·54	−5·07	−4·70
	30	+16·56	−1·87	−4·07	−1·24	−0·98	−0·95
July	1	+18·88	+0·36	−1·59	−1·65	−1·60	−1·78
	2	+19·95	+1·89	−0·23	−0·64	−1·03	−1·28
	3	+19·63	+1·52	−0·21	−0·56	−1·16	−1·53
	5	+18·23	+0·95	−0·74	−1·13	−2·39	−2·63
	7	+19·58	+2·97	+1·42	+0·64	−0·71	−1·01
	10	+20·59	+4·50	+3·33	+0·86	−0·20	−0·40
	11	+18·10	+2·24	+0·82	+1·83	+0·89	+0·86
	12	+20·84	+4·67	+3·49	+1·53	+0·88	+0·74
	26	+16·22	−2·58	−4·62	−0·48	+0·02	+0·41
	27	+14·42	−4·18	−6·21	−0·99	−0·72	−0·56
	28	+18·88	+0·60	−1·36	−4·54	−4·60	−4·64
	29	+19·25	+1·18	−0·68	−1·30	−1·61	−1·81

Day, 1887.	Errors of Longitude. Hansen *minus* Observed.			Errors of Ecliptic P.D. Hansen *minus* Observed.		
	Uncorrected for the Change of t made in 1864, but corrected for the Mean Error of the Tables 1847 to 1863.	Corrected by Newcomb.	Corrected for the Change of t made in 1864, and for the Mean Error of the Tables 1847 to 1863.	Uncorrected for the Change of t made in 1864.	Corrected by Newcomb.	Corrected for the Change of t made in 1864.
	″	″	″	″	″	″
July 30	+20·39	+2·63	+0·75	−0·42	−1·16	−1·31
31	+21 07	+3·51	+1·83	+2·18	+1·32	+0·98
Aug. 2	+19·68	+2 41	+1·10	+0·33	−1 04	−1·27
3	+19·87	+3·21	+1·61	+1 98	+0·82	+0·29
4	+19·91	+3 28	+1·91	+1·09	−0·50	−0·59
5	+20·64	+4·29	+2·93	−0 31	−1·53	−1·87
6	+17·84	+1 58	+0·40	+2 07	+1 23	+0·72
7	+17 07	+1·42	−0 31	+3·10	+2·39	+1·96
8	+19 50	+3·78	+2·29	+1·76	+1 09	+0·89
23	+17·37	−1·45	−3·89	+1·11	+1·69	+1·70
24	+20 21	+1·23	−0 53	−1·89	−2·08	−1·83
25	+18·87	+0·46	−1·35	+1·37	+0·79	+1·01
31	+19·71	+2·97	+1·74	+0 62	−0·63	−1·02
Sept. 2	+20·94	+4·62	+3·43	+1·12	+0·16	−0·30
6	+21·29	+5·23	+3·91	+0·79	+0·39	+0·43
7	+17·27	+1·03	−0·34	+2·32	+2·27	+2·29
8	+19 09	+2 63	+1 21	−0·09	+0·20	+0·23
28	+20·21	+3·68	+2·49	+2·36	+1 03	+0 80
29	+19·16	+3·22	+1·60	+3·17	+1·54	+1·74
Oct. 1	+18·27	+2·21	+0 82	+2·61	+1·73	+1·63
2	+17·59	+1·81	+0·20	+1·19	+0·73	+0·45
10	+19·22	+1·19	−0·52	−0·54	+0·75	+1·13
22	+19 72	+1·95	+0·15	−0·74	−1·92	−2·30
24	+20·31	+3·55	+2 03	+1·00	−0·34	−0·62
25	+20·10	+3·69	+2·23	+2 66	+1·38	+1·07
28	+18·93	+2·70	+1·49	+1 84	+0·96	+0·84
30	+17 64	+1·55	+0·04	+1·46	+0·97	+0·97
31	+17·42	+1·18	−0·17	−0·82	−0·73	−0·96
Nov. 1	+19·98	+3 28	+2 22	−0·43	−0·40	−0 25
4	+17·67	+0·71	−0·69	−1·80	−0·71	−0·69
5	+15·56	−1·41	−3·08	−1·27	+0·01	+0·12
25	+17 60	+1·47	+0·09	+3·01	+2·32	+2·20

Day, 1887.	Errors of Longitude. Hansen *minus* Observed.			Errors of Ecliptic P.D. Hansen *minus* Observed.		
	Uncorrected for the Change of t made in 1864, but corrected for the Mean Error of the Tables 1847 to 1863.	Corrected by Newcomb.	Corrected for the Change of t made in 1864, and for the Mean Error of the Tables 1847 to 1863.	Uncorrected for the Change of t made in 1864.	Corrected by Newcomb.	Corrected for the Change of t made in 1864.
	″	″	″	″	″	″
Nov. 27	+17·92	+1·73	+0·17	+0·96	+0·91	+0·75
29	+17·14	+0·54	−0·90	−0·83	−0·44	−0·29
30	+16·65	−0·10	−1·77	−0·77	−0·36	+0·09
Dec. 5	+18·94	+0·95	−0·86	−3·52	−2·17	−1·75
6	+14·99	−3·33	−5·16	−3·48	−2·06	−1·81
8	+20·49	+1·15	−0·64	−3·53	−2·63	−2·34
26	+15·63	−1·15	−2·50	−1·68	−1·45	−1·27
27	+17·31	+0·34	−1·03	−1·85	−1·19	−1·10
31	+17·95	+0·02	−1·84	−2·09	−0·58	−0·28
Sums, without regard to signs	1866″·88	254″·11	249″·44	182″·24	134″·93	132″·05
Means, without regard to signs	18″·13	2″·47	2″·42	1″·77	1″·31	1″·28
Mean Errors for the year	+18″·13	+0″·71	−0″·91	...	...	...

Radcliffe Observatory, Oxford:
1891 *January* 8.

Photographic Evidence of Variability in the Nucleus of the Great Nebula in Andromeda. By Isaac Roberts, F.R.S.

The photographic evidence of variability in the nucleus of the great nebula in *Andromeda* will best be appreciated if I give in chronological order the dates when the photographs were taken, and describe the appearance of the nucleus on each plate.

On August 30, 1885, a plate was exposed during 30 minutes, when the nucleus did not appear to be distinctly stellar. The Nova was then near, and was much brighter than the nucleus. The star images on the plate, including that of the Nova, are elongated because of bad clock driving, but the nucleus does not show elongation, though stars which were as faint as the nucleus are elongated.

On October 24, 1886, a plate was exposed during 73 minutes, and it shows a faint stellar nucleus, which is elongated and two centred, like all the stars on the plate.

On October 10, 1887, a plate was exposed during 3 hours, which shows the nucleus very faintly stellar, and it is elongated like all the stars on the plate. The rings surrounding the nebula are visible on this plate, but I did not obtain full evidence of their true character until the end of 1888.

On November 15, 1887, a plate was exposed during 2 hours and 35 minutes, but no trace of a stellar nucleus can be detected. The stars on the plate are elongated, but there is no elongation of the nucleus. There is a faint trace of the rings visible.

On October 1, 1888, a plate was exposed during 2 hours, but there is no stellar nucleus visible. The rings are strongly shown.

On October 2, 1888, a plate was exposed during 2 hours and 32 minutes, but the nucleus is not stellar. The rings are strongly shown.

On December 29, 1888, a plate was exposed during 4 hours, on which the rings are strongly shown, but there is no stellar nucleus.

On October 12, 1890, a plate was exposed during 3 hours and 5 minutes, but the nucleus is not stellar.

On November 1, 1890, a plate was exposed during 15 minutes, and the nucleus is distinctly stellar. Its stellar character is more strongly shown on this negative than on the others where it is visible.

On December 9, 1890, a plate was exposed during 15 minutes, and also another immediately following it, with an exposure of 5 minutes, and a stellar nucleus is very strongly shown on both plates. On another plate, which was exposed on the same night during one hour, the stellar nucleus is strongly visible through the nebulosity.

From the evidence given above we may reasonably infer that the nucleus of the nebula is variable, and that it will be practicable to study the character of the variability without the necessity of giving long exposures of the plates.

Summary of the evidence given above:—

1885 August 30. Exposure 30 minutes. No stellar nucleus.

1886 October 24. Exposure 73 minutes. Faint stellar nucleus.

1887 October 10. Exposure 3 hours. Very faint stellar nucleus.

1887 November 15. Exposure 2 hours and 35 minutes. No trace of a stellar nucleus.

1888 October 1. Exposure 2 hours. No stellar nucleus.

1888 October 2. Exposure 2 hours and 32 minutes. No stellar nucleus.

1888 December 29. Exposure 4 hours. No stellar nucleus.

1890 October 12. Exposure 3 hours and 5 minutes. No stellar nucleus.

1890 November 1. Exposure 15 minutes. The nucleus is very strongly stellar.

1890 December 9. Exposures 5, 15, and 60 minutes respectively. The nucleus is strongly stellar on each plate.

Isaac Roberts' New Observatory on Crowborough Hill, Sussex.
By Isaac Roberts, F.R.S.

The observatory is placed on the summit of Crowborough Hill, in Sussex, which is one of the highest points in the South of England, and commands the horizon around without material obstruction. The floor of the observatory is 780 feet 7 inches above sea-level. The whole of the buildings are erected on a level platform of concrete, the top of which is about four feet above the ground, which slopes towards the south-east. The buildings are one story in height, and the floors are raised fifteen inches above the platform or terrace, and are on one uniform level throughout. The limit to one story in height permits the telescopes to be brought down to within twenty degrees of the horizon when pointed over the roof of the house. The observatory is placed due south, and is 20 feet square inside, with a transit room opening from it on the west side. Adjoining the observatory on the north side is a physical laboratory and a chemical laboratory, with dark room and photo-enlarging arrangements. These and the observatory are connected with the dwelling-house by a corridor, on one side of which is a mechanic's shop, heating-chamber, and library. At the end of the corridor is the dwelling-house. The dome of the observatory is hemispherical, and constructed with wood ribs, sheeted with wood and covered with copper. The dome has two slits, each 3 feet 8 inches in width, parallel with each other, and 5 feet 8 inches from centre to centre. The shutters of the lower half of each slit slide horizontally round the dome, and the upper halves slide upon and over the top of the dome, so that both slits can be opened full breadth from the horizontal to 18 inches beyond the zenith. By opening both slits the observatory is soon cooled down to the external temperature; but there is one disadvantage in this dual slit plan—it gives the dome a pole, which in some positions of the telescope is a little troublesome.

The latitude of the observatory is N. 51° 3′ 7″; longitude, E. $0^h\ 0^m\ 37^s$.

The site of the observatory was selected after much inquiry and investigation as to probability of the occurrence of numerous clear intervals of sky during the year suitable for the pursuit of stellar photography, and although it is premature to express a decided opinion, I am quite safe in stating that this locality is an improvement upon the former site of my observatory at Maghull.

It may interest some to know that I commenced building the observatory and house in the month of September 1889, and by September 1890 the buildings were finished and occupied, and some ten tons weight of telescopes, apparatus, and books were dismounted, conveyed, and re-erected on Crowborough Hill within twelve months time.

Accompanying is a photograph of the buildings.

The photographic work was continued at Maghull till the month of June 1890, and resumed at Crowborough in the following October.

Observations of the Planets Victoria and Sappho and comparison stars made with the Meridian Circle at Dunsink. By Arthur A. Rambaut, M.A., Assistant Astronomer at Dunsink Observatory.

(*Communicated by Sir Robert Ball.*)

In accordance with a request of Dr. Gill, the meridian circle and chronograph of the Dunsink Observatory were employed during the summer, autumn, and part of the winter of 1889–90, in observing the minor planets *Victoria* and *Sappho*, as well as the list of comparison stars selected by Dr. Gill for heliometer observations of parallax.

A precisely similar series of observations had been made during the previous year upon the planet *Iris* and comparison stars, the results of which were published in vol. xlix., No. 5, of the *Monthly Notices*.

In passing I should like to take this opportunity to correct a misprint which escaped my notice on p. 313 and subsequent pages of that communication. The date for which the places are computed is there given as 1880·0 throughout the whole list of separate results, instead of 1888·0, as it ought to be. This misprint is, however, the less likely to have misled anybody as the means of these results are correctly given in a collected list at the end of the paper as being for 1888·0.

I regret to say that the observations contained in the present communication are not so complete as might have been wished. Those of the comparison stars for *Victoria* in particular are a mere fragment of what it was proposed to obtain, owing to frequent interruption which occurred in the work; and although the results for the *Sappho* list are more satisfactory, there are still some stars of which I failed to get as many observations as suggested by Dr. Gill.

The places of the stars given below are, as in the case of the *Iris* list, differential, both in right ascension and declination, the clock error and the equator point of the circle being always determined by observations of a few stars selected from the *Berliner Jahrbuch*.

(I.) *Victoria and Comparison Stars.*—In the case of the *Victoria* series the standard stars selected were :—

List of Standard Stars.

No.	No. in Fund. Cat.	Name.	Mean R.A. 1889·0. h m s	Mean Decl. 1889·0. ° ′ ″
1	257	η Serpentis	18 15 33·936	− 2 55 36·96
2	266	θ Serpentis p.	18 50 42·062	+ 4 3 35·53
3	269	λ Aquilæ	19 0 21·464	− 5 2 54·37
4	604	π Sagittarii	19 3 9·754	−21 11 58·31
5	290	ϵ Delphini	20 27 54·589	+10 55 34·83
6	610	υ Capricorni	20 33 43·848	−18 31 44·22
7	297	ϵ Aquarii	20 41 40·012	− 9 54 6·35
8	256	δ Ursæ Min. U.C.	18 8 7·059	+86 36 40·98
9	111	51 H. Cephei L.C.	6 48 16·901	+87 13 9·41
10	508	76 Draconis	20 50 35·033	+82 7 10·40

The numbers in the eighth column of the following table refer to this list, the symbol (α) after a number denoting that the corresponding star has only been observed in Right Ascension. This symbol has been omitted in the case of the last three stars on the list, which were observed only in right ascension for the purpose of determining the azimuth error of the instrument. In other respects the table is similar to the corresponding one in the *Iris* observations, and requires no further explanation.

It should be remarked that throughout the *Victoria* observations the instrument was in the position Clamp W.

Table of Instrumental Corrections at $19^h{\cdot}5$ *Sidereal Time.*

Date. 1889.	Incl. s	Azim. s	Collim. s	$\Delta t + b \sec\phi$. s	Equator Point (S.) ° ′ ″	(N.) ″	Standard Stars.
June 10	+0·184	−0·068	+0·080	− 33·41	171 36 27·30	26·90	3(α), 4, 5, 6, 9
July 3	+0·243	−0·148	+0·051	− 72·11		27·36 27·03	2, 3, 5, 6, 8
29	+0·154	−0·159	+0·022	−127·10		25·73 25·61	1, 2, 3, 5, 6, 8
Aug. 17	+0·221	+0·276	+0·056	− 48·15		26·90 27·41*	3, 5, 6, 7, 10
20	+0·198	+0·214	+0·047	− 54·88		26·78 26·80	1, 2, 3, 6, 7, 8

Observations of the planet Victoria.

[The places given in this list are not corrected for annual aberration or parallax.]

Date. 1889.	App. R.A. h m s	App. Decl. ° ′ ″	Remarks.
July 3	19 54 15·66	−5 44 45·6	V.v. faint. Dark field.
29	33 28·78	−4 40 5·9	Faint. Bright field.
Aug. 17	24 56·71	−5 29 28·9	
20	24 41·65	−5 41 35·1	Dark field. Through clouds.

* Only two readings of Nadir-point.

Observations of Victoria Comparison Stars.

No.	D.M.	Date. 1889.	R.A. 1889·0. h m s	Decl. 1889·0. ° ′ ″	Remarks.
a	−8°, 4887	July 3	19 6 39·39	−8 7 27·1	
		29	39·44	27·7	
		Aug. 17	39·50	29·5	
		20	39·35	27·5	Decl. good.
			19 6 39·420	−8 7 27·95	
b	−5°, 4936	June 10	19 14 37·28	−5 37 21·3	Unsteady.
		July 3	37·38	19·6	Perhaps a little too much south.
		29	37·30	20·6	
		Aug. 17	37·36	22·3	
		20	37·31	21·5	
			19 14 37·326	−5 37 21·06	
1	−6°, 5151	June 10	19 21 25·22	−5 57 22·2	Unsteady.
		July 3	25·30	20·2	V. faint. Dark field.
			19 21 25·260	−5 57 21·20	
2	−6°, 5158	July 29	19 23 2·71	−6 24 0·2	Unsteady. Bright field.
6	−5°, 5006	June 10	19 27 50·40	−4 58 49·6	Unsteady.
		July 3	50·61	49·4	V. faint. Dark field.
		29	50·53	49·1	Bright field.
			19 27 50·513	−4 58 49·37	
9	−5°, 5021	Aug. 20	19 30 41·13	−5 1 2·2	
12	−4°, 4861	17	19 31 54·00	−4 53 40·6	
15	−4°, 4883	June 10	19 35 55·94	−4 32 50·5	Unsteady.
		July 3	56·09	49·2	Faint. Dark field.
		Aug. 20	56·09	49·4	Dark field. Clouds.
			19 35 56·040	−4 32 49·70	
16	−4°, 4903	July 29	19 39 23·65	−4 47 22·3	Dark field.
		Aug. 17	23·77	23·5	Dark field.
			19 39 23·710	−4 47 22·90	
17	−4°, 4916	Aug. 20	19 40 59·39	−3 56 0·0	Dark field.

No.	D.M.	Date. 1889.	R.A. 1889·0. h m s	Decl. 1889·0. ° ′ ″	Remarks.
19	−4°, 4926	June 10	19 43 4·49	−4 46 19·1	Unsteady.
		July 3	4·54	18·8	Dark field.
		29	4·54	20·3	Dark field.
		Aug. 17	4·40	17·8	Dark field.
			19 43 4·492	−4 46 19·00	
22	−4°, 4960	Aug. 20	19 47 27·16	−4 51 31·4	Dark field.
23	−5°, 5099	July 3	19 48 22·59	−5 19 59·3	
		Aug. 17	22·46	59·9	Dark field.
			19 48 22·525	−5 19 59·60	
24	−5°, 5120	June 10	19 51 25·92	−4 58 53·5	Unsteady. Daylight getting very bright.
		July 29	25·94	52·4	
			19 51 25·930	−4 58 52·95	
27	−4°, 4984	Aug. 20	19 52 38·10	−4 39 16·2	Dark field. Good.
28	−4°, 4992	Aug. 17	19 54 57·31	−4 36 53·7	
31	−8°, 5205	June 10	19 57 4·84	−8 0 13·7	Unsteady. Daylight getting very bright.
32	−5°, 5144	July 29	19 57 21·86	−4 56 27·6	Bright field.
		Aug. 20	21·69	27·8	Bright field.
			19 57 21·775	−4 56 27·70	
34	−4°, 5016	Aug. 17	20 0 44·87	−4 44 4·4	
35	−7°, 5169	July 3	20 0 46·87	−7 19 56·2	Dark field.
37	−9°, 5382	July 3	20 5 8·99	−9 10 13·2	Dark field.
		29	8·95	12·7	Bright field. Good.
		Aug. 17	8·98	13·7	Set in decl. after transit at IV. Dark field.
		20	8·82	12·1	
			20 5 8·935	−9 10 12·92	
c	−6°, 5451	June 10	20 14 31·40	−6 42 29·0	Unsteady.
		July 3	31·60	29·3	
		29	31·58	28·1	
		Aug. 17	31·58	29·8	
		20	31·52	29·2	
			20 14 31·536	−6 42 29·08	

No.	D.M.	Date. 1889.	R.A. 1889·0 h m s	Decl. 1889·0. ° ′ ″	Remarks.
d	−3°, 4888	July 3	20 19 55·06	−3 9 35·6	
		29	54·95	34·5	
		Aug. 17	55·08	35·6	
		20	55·04	34·2	
			20 19 55·032	−3 9 34·98	

(II.) *Sappho and Comparison Stars.*—The standard stars selected from the *Berliner Jahrbuch* for the *Sappho* series are contained in the following list:—

List of Standard Stars.

No.	No. in Fund. Cat.	Name.	R.A. 1889·0 h m s	Decl. 1889·0 ° ′ ″
1	538	ϕ Pegasi	23 46 50·439	+18 30 13·34
2	336	ω Piscium	23 53 36·659	+ 6 14 55·58
3	339	12 Ceti	0 24 22·442	− 4 34 14·84
4	25	o Piscium	1 39 31·894	+ 8 35 55·56
5	29	ξ Piscium	1 47 48·536	+ 2 38 21·19
6	33	α Arietis	2 0 54·962	+22 56 14·04
7	334	γ Cephei, U.C.	23 34 47·756	+77 0 45·76
8	168	4 H. Draconis, L C.	12 6 59·505	+78 13 59·42

The last two stars on this list, Nos. 7 and 8, have been observed only in right ascension for the determination of the azimuth correction. Both of these were observed on every occasion with the exception of the three following dates—November 18 and 28 and December 15—on which clouds interfered with the transit of one or other of them.

Table of Instrumental Corrections at $0^{h}\cdot5$ *Sidereal Time.*

Date.	Clamp.	Incl.	Azim.	Collim.	$\Delta t + b \sec\phi$	Equator Point (S.)	(N.)	Standard Stars.
1889.		s	s	s	s	° ′ ″	″	
Aug. 30	W	+0·215	+0·079	+0·081	− 76·16	171 36 27·48	26·42	1, 2, 3, 4, 5, 7, 8
Sept. 17	,,	+0 229	+0·022	+0·040	−111·74	28·48	28·49	1, 2, 3, 4, 5, 7, 8
19	,,	+0·252	+0·139	+0·062	−116·02	29·55	28·96	1, 2, 3, 4, 5, 7, 8
24	,,	+0·189	+0·092	+0·025	−126·50	28·57	27·73	1, 2, 4, 5, 7, 8
25	,,	+0·187	+0·123	+0·052	−128·42	28·81	28·28	1, 2, 3, 7, 8
Oct. 7	,,	+0·100	+0·013	+0·006	−150·26	28·55	28·52	1, 2, 4, 5, 7, 8
8	,,	+0·129	+0·343	+0·129	−152·70	29·72	28·68	1, 2, 3 (*a*), 4, 5, 7, 8
10	,,	+0·078	+0·117	+0·078	−156·58	28·51	27·57	1, 2, 3, 4, 5, 7, 8
11	,,	+0·084	+0·200	+0·084	−158·46	29·31	28·36	1, 2, 3, 4, 5, 7, 8
12	,,	+0·078	+0·088	+0·078	−160·11	28·52	27·91	1, 2, 3, 4, 5, 7, 8
13	,,	+0·081	+0·220	+0·081	−161·92	29·21	28·48	1, 2, 3, 4, 5, 7, 8
30	,,	+0 033	+0·011	[0·000]	−190·14	28·12	27·04	1, 2, 3, 4, 5, 7, 8

		s	s	s	s	° ′ ″	″	
1889. Nov. 16	E	+ 0·081	+ 0·264	+ 0·081	− 32·63	171 37 39·81	39·93	1, 2, 3, 4, 5, 7, 8
18	,,	+ 0·055	+ 0·210	+ 0·055	− 34·83	39·16	39·83*	3, 4, 5, 8
19	,,	+ 0·056	+ 0·128	+ 0·056	− 35·95	39·66	39·52	1, 2, 3, 4, 5, 7, 8
25	,,	+ 0·077	+ 0·273	+ 0·077	− 44·19	40·62	40·56	1, 2, 3, 4, 5, 7, 8
27	,,	+ 0·042	− 0·033	− 0·041	− 47·35	40·01	39·86	1, 2, 3, 4, 5, 7, 8
28	,,	+ 0·035	− 0·026	[− 0·033]	− 48·92	40·47	...	3, 5, 6, 8
Dec. 7	,,	− 0·022	+ 0·207	+ 0·043	− 59·95	39·10	39·03	1, 2, 3, 4, 5, 7, 8
10	,,	− 0·040	+ 0·221	+ 0·068	− 63·63	39·01	38·17*	1, 2, 3, 4, 5, 7, 8
11	,,	− 0·022	+ 0·088	+ 0·049	− 64·88	40·61	40·27	1, 2, 3, 4, 5, 7, 8
15	,,	− 0·062	− 0·095	+ 0·006	− 70·02	38·76	...	1, 2, 3, 7
20	,,	0·000	+ 0·070	+ 0·059	− 74·14	40·26	...	1, 2, 3, 4, 5, 7, 8
24	,,	+ 0·008	+ 0·072	+ 0·059	− 78·50	39 74	...	1, 2, 3, 4, 5, 7, 8
1890. Jan. 2	W	− 0·039	− 0·074	+ 0·026	− 86·79	171 36 26·05	25·87†	1, 2, 3, 4, 5, 7, 8

* Only two readings of the Nadir point.

† Only one reading.

Observations of the Planet Sappho.

[The places given in this list are not corrected for annual aberration or parallax.]

Date.	App. R.A.	App. Decl.	Remarks.
	h m s	° ′ ″	
Sept. 17	1 9 9·73	+17 9 38·5	Dark field. Appears 9m.
24	1 5 34·82	+16 9 49·7	Distinctly fainter than D.M. + 16°, 123, slightly fainter than, but almost exactly equal to D.M. + 15°, 173. A very deliberate, good comparison. Estimated mag. 9·2.
Oct. 7	0 56 52·52	+13 42 7·9	Dark field.
8	0 56 10·24	+13 29 25·0	
10	...	+13 3 38·3	Appeared through clouds just at edge of field.
11	0 54 4·89	+12 50 41·8	Distinctly brighter than D.M. + 12°, 120, a little brighter than D.M. + 12°, 123. Estimated mag. 8·9.
12	0 53 23·97	+12 37 39·8	Seemed same mag. as D.M. + 12°, 120 (i.e. 9·5), but comparison was hurried.
13	0 52 43·57	+12 24 34·6	Estimated 9m·2. Brighter than D.M. + 8°, 139. Dark field.
30	0 43 59·08	+ 8 51 31·1	Varying in brightness through clouds. Dark field.

Observations of Sappho Comparison Stars.

No.	D.M.	Date. 1889.	Clamp.	R.A. 1889·0. h m s	Decl. 1889·0. ° ′ ″	Remarks.
e	+10°, 065	Aug. 30	W	0 31 32·15	+10 49 32·3	
		Sept. 17	,,	31·97	31·2	
		19	,,	32·05	32·7	
		24	,,	32·09	32·0	
		25	,,	31·95	33 2	
		Oct. 7	,,	32·05	33 0	
		8	,,	32·04	31·5	Only five wires.
		10	,,	32·01	31·9	
		11	,,	32·09	31·8	
		12	,,	32·04	32·0	Good.
		13	,,	32·02	32·0	
		30	,,	31·99	31·6	Definition bad.
		Nov. 16	E	32·03	32·1	
		18	,,	32·10	32·2	
		19	,,	32·02	31·8	
		25	,,	32·03	32·9	
		27	,,	32·09	31·9	Decl. bad. Very unsteady when setting.
		28	,,	32·11	32·6	Rather faint. Clouds.
		Dec. 7	,,	31·99	33·1	
		10	,,	32·05	32·7	See note (*a*).
		11	,,	32·02	32·9	Dark field.
		15	,,	31·90	32·6	Dark field.
		20	,,	32·05	32·9	
		24	,,	32·03	32·2	
		1890. Jan. 2	W	32·02	32·0	
				0 31 32·036	+10 49 32·28	

No.	D.M.	Date. 1889.	Clamp.	R.A. 1889·0. h m s	Decl. 1889·0. ° ′ ″	Remarks.
f	+15°, 106	Aug. 30	W	0 37 4·28	+16 3 23·7	
		Sept. 17	„	4·20	24·5	
		19	„	4·29	24·4	
		24	„	4·34	23·5	
		25	„	4·20	23·9	
		Oct. 7	„	4·27	24·0	
		8	„	4·26	23·1	
		10	„	4·22	23·6	
		11	„	4·29	23·9	
		12	„	4·32	23 9	
		13	„	4·27	22·6	
		30	„	4·28	23·3	Definition bad. Set hurriedly in decl., but seemed good.
		Nov. 16	E	4·24	22·7	
		18	„	4·26	23·0	
		19	„	4·24	22·8	
		25	„	4·24	23·0	
		27	„	4·32	23·9	
		28	„	[4·43]	23·2	Dark field. Very faint through clouds.
		Dec. 7	„	4·25	22·6	
		10	„	4·23	22·7	
		11	„	4·26	22·6	Dark field.
		15	„	4·16	23·8	See note (*b*).
		20	„	4·27	22·8	
		24	„	4·27	22·6	
		1890. Jan. 2	W	4·28	24·2	
				0 37 4·260	+16 3 23·37	
l	+ 8°, 110	1889. Aug. 30	W	0 42 25·31	+ 8 36 56·4	Rather faint for bright field.
		Sept. 17	„	25·25	57·2	
		Oct. 12	„	25·24	56·9	Faint.
		Nov. 18	E	25·28	56·1	
		28	„	25·25	57·2	Dark field. Faint through clouds.
				0 42 25·266	+ 8 36 56·76	

No.	D.M.	Date.	Clamp.	R.A. 1889·0.	Decl. 1889·0.	Remarks.
		1889.		h m s	° ′ ″	
2	+ 9°, 090	Sept. 19	W	0 42 31·09	+ 9 39 11·8	
		Oct. 11	,,	31·05	11·5	
		Dec. 10	E	31·06	11·3	Faint through clouds.
				0 42 31·067	+ 9 39 11·53	
3	+ 11°, 102	Sept. 25	W	0 44 24·23	+ 11 13 36·8	Dark field.
		Nov. 25	E	24·35	36·2	Dark field. Not so bright as 8ᵐ·6.
		27	,,	24·35	36·5	Dark field.
		1890. Jan. 2	W	24·33	...	Dark field.
				0 44 24·315	+ 11 13 36·50	
		1889.				
4	+ 9°, 097	Oct. 7	W	0 44 46·76	+ 9 48 25·7	
		Nov. 16	E	46·77	23·5	
		Dec. 11	,,	46·78	24·6	
				0 44 46·770	+ 9 48 24·60	
5	+ 11°, 106	Sept. 24	W	0 45 46·18	+ 12 10 52·3	
		Oct. 8	,,	46·12	52·4	Thin clouds.
		13	,,	46·14	51·9	
		Nov. 19	E	46·10	52·3	
		Dec. 7	,,	46·14	52·8	
		15	,,	46·08	53·1	Dark field. Decl. good.
				0 45 46·127	+ 12 10 52·47	
6	+ 9°, 099	Oct. 10	W	0 46 20·51	+ 9 59 53·0	Dark field. Clouds.
		Dec. 20	E	20·46	53·3	
		24	,,	20·46	52·4	Dark field. Only 5 wires. Decl. good.
		1890. Jan. 2	W	20·34	52·2	Dark field. R.A. $\frac{1}{2}$ weight.
				0 46 20·457	+ 9 59 52·72	
		1889.				
7	+ 12°, 104	Oct. 12	W	0 46 40·02	+ 13 2 44·5	
		Nov. 28	E	40·01	43·9	Dark field.
				0 46 40·015	+ 13 2 44·20	
8	+ 9°, 101	Aug. 30	W	0 47 0·68	+ 9 12 3·9	
		Dec. 10	E	0·62	6·2	
				0 47 0·650	+ 9 12 5·05	

No.	D.M.	Date. 1889.	Clamp.	R.A. 1889·0. h m s	Decl. 1889·0. ° ′ ″	Remarks.
9	+ 10°, 105	Sept. 17	W	0 48 3·00	+ 10 31 11·7	
		19	„	2·92	11·9	
		Oct. 11	„	2·91	14·4	
		Nov. 18	E	3·01	11·8	Faint.
				0 48 2·960	+ 10 31 12·45	
10	+ 12°, 108	Oct. 30	W	0 49 12·00	+ 12 14 41·4	
		Nov. 25	E	11·96	44·8	
				0 49 11·980	+ 12 14 44·60	
11	+ 13°, 127	Sept. 25	W	0 50 19·67	+ 13 21 1·9	
		Nov. 19	E	19·62	1·1	
		Dec. 20	„	19·67	1·8	
				0 50 19·653	+ 13 21 1·60	
12	+ 11°, 118	Oct. 8	W	0 50 40·41	+ 12 6 44·3	Very changeable through clouds.
		Nov. 27	E	40·39	45·4	Dark field.
				0 50 40·400	+ 12 6 44·85	
13	+ 13°, 130	Oct. 10	W	0 50 52·36	+ 14 10 32·0	Dark field. V. faint through clouds.
		Dec. 7	E	52·24	29·3	
				0 50 52·300	+ 14 10 30·65	
14	+ 9°, 110	Oct. 7	W	0 50 59·21	+ 9 24 54·4	Dark field.
		Dec. 11	E	59·27	53·6	Faint.
				0 50 59·240	+ 9 24 54·00	
15	+ 11°, 120	Sept. 24	W	0 51 32·84	+ 11 49 44·8	Definition bad.
		Nov. 16	E	32·80	46·1	
		Dec. 24	„	32·93	46·8	
				0 51 32·857	+ 11 49 45·90	
16	+ 12°, 119	Aug. 30	W	0 52 4·99	+ 13 5 44 8	
		Nov. 18	E	5·04	45·3	
		28	„	4·99	45·4	Dark field. Excellent.
		Dec. 15	„	4·89	46·1	Dark field. Decl. good.
		1890. Jan. 2	W	5·01	44·2	
				0 52 4 984	+ 13 5 45·16	

No.	D.M.	Date. 1889.	Clamp.	R.A. 1889·0. h m s	Decl. 1889·0. ° ′ ″	Remarks.
17	+13°, 143	Sept. 17	W	0 53 53·66	+14 0 39·2	
		Dec. 10	E	53·71	37·5	Dark field.
				0 53 53·685	+14 0 38 35	
18	+10°, 115	Oct. 30	W	0 55 25·55	+10 34 59 0	
		Dec. 20	E	25·55	59·3	
				0 55 25·550	+10 34 59 15	
19	+11°, 135	Sept. 19	W	0 55 32·91	+11 18 53·0	Dark field.
		Nov. 19	E	32·84	50·6	
		25	,,	33·03	...	
		27	,,	32·92	51·5	
		Dec. 12	,,	32·83	51·6	
				0 55 32·906	+11 18 51 67	
20	+13°, 150	Sept. 25	W	0 56 43·39	+13 39 19·8	
		Nov. 18	E	43·57	18·3	
		Dec. 11	,,	43·57	17·1	
				0 56 43·510	+13 39 18·40	
21	+15°, 154	Nov. 16	E	0 57 9·69	+15 32 26·5	
		1890. Jan. 2	W	9·62	26·5	Very faint.
				0 57 9·655	+15 32 26·50	
22	+12°, 126	1889. Sept. 24	W	0 57 16·37	+12 27 10·1	
		Dec. 24	E	16·35	10·8	
				0 57 16·360	+12 27 10·45	
23	+13°, 155	Oct. 13	W	0 58 0·46	+13 20 27·5	
24	+14°, 163	Aug. 30	,,	0 59 13·72	+14 20 57·1	
		Sept. 17	,,	13·73	56·6	
		Oct. 12	,,	13·72	56·3	Unsteady. Dark field.
		Nov. 28	E	13·78	56·9	
		Dec. 15	,,	13·67	56·5	
				0 59 13·724	+14 20 56·68	

No.	D.M.	Date. 1889.	Clamp.	R.A. 1889·0. h m s	Decl. 1889·0. ° ′ ″	Remarks.
25	+14°, 168	Oct. 11	W	0 59 57·06	+14 23 16·4	Illumination of wires bad.
		Dec. 10	E	56·97	15·8	Dark field.
				0 59 57·015	+14 23 16·10	
25*a*	+14°, 169	Nov. 19	E	1 0 4·30	+14 47 23·8	
		25	„	[4·65]	[22·9]	See note (*c*).
		Dec. 7	„	4·29	24·6	
				1 0 4·295	+14 47 24·20	
26	+15°, 159	Nov. 27	E	1 0 29·64	+15 43 10·4	
		Dec. 20	„	29·61	10·0	Very faint through clouds.
				1 0 29·625	+15 43 10·20	
27	+15°, 164	Sept. 19	W	1 1 59·51	+15 16 15·7	Very faint through clouds. Dark field.
		Oct. 8	„	59·47	15·5	
		Nov. 18	E	59 52	16·3	
				1 1 59·500	+15 16 15·83	
28	+16°, 116	Oct. 7	W	1 2 2·09	+16 49 12·0	
		Dec. 11	E	2·17	10·9	Good.
				1 2 2·130	+16 49 11·45	
29	+16°, 119	Sept. 25	W	1 2 34·87	+17 3 [43·9]	See note (*d*).
		Oct. 10	„	34·84	41·0	Dark field.
		13	„	34·84	40·7	Definition not good. Dark field.
		Nov. 16	E	34·84	41·1	
		Dec. 24	„	34·88	41·2	
				1 2 34·854	+17 3 41·32	
30	+14°, 175	Sept. 17	W	1 4 18·33	+15 4 59·2	
		Nov. 28	E	18·32	59·4	
		Dec. 15	„	18·20	59·6	
				1 4 18·283	+15 4 59·40	
31	+17°, 166	Oct. 12	W	1 5 3·71	+17 48 6·8	
		Dec. 10	E	3·72	6·5	Dark field.
				1 5 3·715	+17 48 6·65	

No.	D.M.	Date 1889.	Clamp.	R.A. 1889·0. h m s	Decl. 1889·0. ° ′ ″	Remarks.
32	+16°, 123	Aug. 30	W	1 5 10·11	+16 11 12·5	
		Oct. 30	„	10·23	12·7	Definition bad.
		Nov. 19	E	10·18	12·9	
		Dec. 20	„	10·24	12·4	
				1 5 10·190	+16 11 12·62	
33	+13°, 175	Oct. 1	W	1 5 24·04	+14 6 6·1	
		Nov. 27	E	24·04	6·0	
		Dec. 7	„	24·05	6·9	
				1 5 24·043	+14 6 6·33	
34	+15°, 175	Oct. 7	W	1 6 55·79	+16 10 29·7	
		Dec. 11	E	55·82	29·3	
				1 6 55·805	+16 10 29·50	
35	+15°, 177	Oct. 8	W	1 8 13·76	+15 32 45·1	
		13	„	13·80	45·4	Dark field. Good.
		Nov. 16	E	13·82	44·2	
		18	„	13·88	44·9	
				1 8 13·815	+15 32 44·90	
36	+16°, 129	Oct. 10	W	1 10 15·81	+17 2 54·1	Dark field. Clouds.
		12	„	15·72	53·9	
		30	„	15·78	53·7	
		Nov. 27	E	15·81	53·7	Ill-defined.
		28	„	15·79	54·0	
		Dec. 24	„	15·75	53·2	
				1 10 15·777	+17 2 53·77	
37	+15°, 185	Sept. 19	W	1 11 34·45	+15 46 10·2	Very faint through clouds at times. Dark field.
		25	„	34·25	9·1	Dark field. Very faint.
		Oct. 11	„	34·30	7·7	
		Nov. 19	E	34·35	9·4	Dark field.
		Dec. 7	„	34·41	9·0	Dark field. Light clouds.
		10	„	34·26	8·2	Dark field.
				1 11 34·337	+15 46 8·93	

No.	D.M.	Date. 1889.	Clamp.	R.A. 1889·0. h m s	Decl. 1889·0. ° ′ ″	Remarks.
38	+17°, 183	Aug. 30	W	1 12 26·01	+17 59 30·8	
		Sept. 24	,,	26·10	31·8	
		Oct. 7	,,	26·06	32·9	
		8	,,	25·99	32·2	
		Nov. 18	E	26·00	30·8	
		Dec. 11	,,	26·05	31·6	
		15	,,	25·95	31·9	Dark field.
		20	,,	26·04	31·7	
				1 12 26·025	+17 59 31·71	
g	+10°, 171	Aug. 30	W	1 17 2·12	+10 47 13·0	Only five wires.
		Sept. 17	,,	2·19	14·7	
		19	,,	2·16	12·8	Declination appeared good. Only five wires.
		24	,,	2·20	13·7	
		25	,,	2·03	14·7	Very changeable through clouds. Dark field.
		Oct. 7	,,	2·17	14·2	
		8	,,	2·16	14·2	
		10	,,	2·17	13·6	Very good.
		11	,,	2·17	13·7	Very good.
		12	,,	2·14	13·9	
		13	,,	2·16	14·1	
		30	,,	2·20	13·8	
		Nov. 16	E	2·18	13·4	
		18	,,	2·19	13·5	
		19	,,	2·15	12·8	
		25	,,	2·11	14·4	Dark field.
		27	,,	2·23	14·3	Ill-defined.
		28	,,	2·21	14·4	
		Dec. 7	,,	2·16	13.6	Dark field.
		10	,,	2·17	14·5	Good.
		11	,,	2·16	13·6	
		15	,,	2·17	15·6	Dark field. Decl. seems good.
		20	,,	2·14	14·0	
		24	,,	2·13	13·5	
		1890. Jan. 2	W	2·11	14·3	Good.
				1 17 2·159	+10 47 13·93	

No.	D.M.	Date. 1889.	Clamp.	R.A. 1889·0. h m s	Decl. 1889·0. ° ′ ″	Remarks.
h	+16°, 154	Aug. 30	W	1 22 25·99	+16 30 16·3	
		Sept. 17	„	26·04	16·9	
		19	„	25·96	16·5	
		24	„	25·98	16·1	
		25	„	25·80	18·3	Dark field. Just visible through clouds.
		Oct 7	„	25·95	17·0	
		8	„	25·87	16·6	
		10	„	25·92	16·7	Very good.
		11	„	25·87	16·9	Definition beautiful.
		12	„	25·92	15·9	Rather unsteady.
		13	„	25·95	16·9	
		30	„	25·92	16·4	
		Nov. 16	E	25·95	17·5	
		18	„	25·93	17·5	
		19	„	25·94	16·6	
		25	„	25·98	16·8	
		27	„	26·04	17·2	Good.
		28	„	25·99	18·0	
		Dec. 7	„	25·88	16·9	
		10	„	25·93	16·8	Good.
		11	„	26·01	16·6	Very good.
		15	„	25·82	18·0	Dark field. Very faint.
		20	„	25·91	19·1	Variable and ill-defined through clouds.
		24	„	25·96	17·3	
		1890. Jan. 2	W	25·98	16·4	Good.
				1 22 25·940	+16 30 17·01	

Notes.

(*a*) Variable in brightness. Faint at times through clouds. Bright field.

(*b*) Transit over first set of wires good in a bright field. Clouds at middle wire. Decl. and second set of wires observed in dark field.

(*c*) Only three wires. Set in decl. through a break in clouds.

(*d*) Microscope V. read at once. The other three not till after the transit of *h*. This was done to get *Sappho*, which, however, was lost in clouds. Dark field. Weight, $\frac{1}{2}$ in decl.

Probable Error of the Resulting Places.

In computing the probable error of these results, I have contented myself with the observations of the four stars which I call *e*, *f*, *g*, and *h*, as it appeared that the comparatively large number of observations obtained for each of these stars would give a more reliable result than could be obtained by taking the difference between each separate result and the mean of a small number of results for each star as the basis of calculation. All the stars of the list, too, being included between +8° and +18° of declination, and all being observed under exactly similar circumstances, any result applicable to the stars *e*, *f*, *g*, *h* will be equally so to the other stars of the list.

From all the observations of *e*, *f*, *g*, *h*, including the right ascension of *f*, on November 28, although this observation has been neglected in taking the mean, I find as the probable error of a single determination of right ascension, reduced to the equator, the quantity

$$\pm 0^{s}\cdot 033,$$

while the probable error of a single determination of declination similarly computed is

$$\pm 0''\cdot 42$$

Spectroscopic Results for the Motions of Stars in the Line of Sight, obtained at the Royal Observatory, Greenwich, in the year 1890. *No. XIV.*

(*Communicated by the Astronomer Royal.*)

The Results here given are in continuation of those printed in the *Monthly Notices*, vol. xxxvi. p. 318, vol. xxxvii. p. 32, vol. xxxviii. p. 493, vol. xli. p. 109, vol. xlii. p. 230, vol. xliii. p. 81, vol. xliv. p. 89, vol. xlv. p. 330, vol. xlvi. p. 126, vol. xlvii. p. 101, vol. xlviii. p. 116, vol. xlix. p. 127, and vol. l. p. 111.

The observations were made with the "half-prism" spectroscope, one "half-prism," with a dispersion of about $18\frac{1}{2}°$ from A to H, being used throughout. A magnifying power of 14 was employed.

The cylindrical lens has always been used in front of the slit, as in the observations made previously to 1881 and since 1882, March 14. The observations of the Sun, Moon, and planets have been made as a check on the general accuracy of the results.

The day specified in the first column is the civil day, and the hour is that of Greenwich civil time, commencing at Greenwich mean midnight, and reckoning from 0 to 24 hours.

The observations were made by Mr. Maunder throughout.

The observations in brackets on September 15 have been rejected, as the comparison with the sky spectrum afterwards showed that the spectroscope was out of adjustment.

Motions of Stars in the Line of Sight in Miles per Second, observed with the Half-prism Spectroscope.

(+ denotes Recession; −, Approach.)

Date. 1890. G.C.T.		No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Measd.	Estimd.	Remarks.
				α Andromedæ.			
	d h						
Aug.	2 0	2	F	−14·3	−10·8	−14·3	Star-line seen fairly well.
	7 0	2	F	−13·7	−58·9	−49·9	Star-line faint.
Sept.	9 0	2	F	− 7·3	− 8·1	− 7·1	Star-line seen fairly well.
	13 23	2	F	− 6·0	−12·5	−14·4	Star-line seen fairly well.
Oct.	1 22	1	F	− 1·2	−11·5	− 7·1	Definition bad.
	9 22	2	F	+ 1·1	+ 1·0	− 1·1	Definition bad.
	11 22	2	F	+ 1·7	−11·9	−14·2	Definition poor.
				β Cassiopeiæ.			
Aug.	7 1	2	F	−11·0	−26·7	−36·7	Star-line seen with difficulty.
Sept.	13 23	2	F	− 7·6	− 7·6	−10·3	Star-line faint.
Oct.	11 20	2	F	− 3·0	−13·6	−13·1	Star-line seen well.
				γ Pegasi.			
Sept.	9 0	2	F	− 6·5	+34·0	+30·6	Star-line seen fairly well.
	11 23	2	F	− 5·7	−54·0	−38·4	Spectrum faint.
	13 22	2	F	− 5·1	−45·2	−45·9	Star-line observed with difficulty.
Oct.	1 22	2	F	+ 0·3	−14·0	−14·8	Definition bad.
	9 22	2	F	+ 2·8	+ 3·6	+ 1·7	Definition poor.
	11 22	2	F	+ 3·4	+ 5·0	+ 5·6	Definition poor.
				α Cassiopeiæ.			
Sept.	15 22	2	b_1	− 8·6	(+36·2)	(+35·2)	Star-line exceedingly faint.
				γ Cassiopeiæ.			
Aug.	7 1	2	F	−11·8	− 7·2	− 8·9	Star-line feebly bright, and observed with great difficulty.
Sept.	13 23	2	F	− 9·3	+ 8·2	+ 9·3	
Oct.	11 20	2	F	− 4·9	+20·0	+20·4	
				δ Cassiopeiæ.			
Sept.	13 23	2	F	− 1·0	−13·5	−14·3	Star-line seen fairly well.
Oct.	11 20	2	F	− 6·0	+74·4	+53·6	Spectrum bright, but very unsteady. Definition bad.

Date. 1890. G.C.T.	No. of Meas.	Line	Earth's Motion in miles per sec.	Concluded Motion of Star. Measd.	Estimd.	Remarks.
			β Arietis.			
Oct. d h 9 22	2	F	− 4·9	− 8·2	− 8·6	Star-line seen fairly well.
			γ Andromedæ.			
Sept. 15 23	2	b_1	−12·3	(−12·9)	(−19·2)	Star-line very faint.
			β Persei.			
Mar. 3 23	2	F	+16·4	−53·0	−57·0	Measures made with great difficulty.
12 22	4	F	+15·2	−58·7	−54·0	Star-line seen fairly well.
Sept. 13 23	4	F	−15·0	+ 2·0	− 2·9	Star-line seen fairly well.
Oct. 9 23	2	F	−10·5	−52·7	−46·6	Star-line seen fairly well.
			α Persei.			
Mar. 12 22	2	F	+14·9	−44·4	−42·5	Star-line seen fairly well.
Sept. 14 0	2	F	−14·7	+ 0·6	− 3·2	Star-line seen fairly well.
Oct. 9 23	2	F	−11·1	+12·3	+11·1	Star-line seen fairly well.
			Aldebaran.			
Jan. 4 22	2	F	+11·2	+63·8	+38·3	Star-line seen with great difficulty.
Feb. 7 20	2	F	+17·7	+23·6	+35·6	Star-line seen with great difficulty.
18 23	2	F	+18·5	+18·7	+32·5	Star-line faint.
Mar. 12 22	2	F	+18·0	+16·8	+20·9	Star-line seen with great difficulty.
17 22	2	b_1	+17·4	+ 4·8	+24·4	Star-lines seen with great difficulty.
			Capella.			
Mar. 3 22	2	F	+17·1	+10·6	+23·5	Star-line seen fairly well.
12 22	2	F	+17·1	+14·7	+26·1	Star-line seen with great difficulty.
17 23	4	b_1	+16·9	+10·2	+32·4	Spectrum very unsteady.
Sept. 14 0	2	F	−16·7	+49·4	+54·1	Star-line faint.
15 23	2	b_1	−16·7	(+57·7)	(+66·0)	Star-line very faint.
			Rigel.			
Feb. 18 20	2	F	+15·5	+29·1	+22·8	Definition fair.
Mar. 3 20	4	F	+16·0	+30·5	+29·6	Spectrum faint and very unsteady.
12 20	2	F	+15·8	+14·7	+22·2	Definition bad.
Apr. 3 20	2	F	+13·7	+ 8·5	+ 6·3	Spectrum unsteady. Star-line faint.

Date. 1890. G.C.T.		No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Measd.	Estimd.	Remarks.
				γ Orionis.			
	d h						
Feb.	18 20	2	F	+17·0	+16·7	+12·8	Definition poor.
Mar.	3 20	2	F	+17·8	+13·2	+14·5	Spectrum faint and very unsteady.
	12 21	2	F	+17·8	−20·7	−17·8	Star-line seen fairly well.
Apr.	3 20	2	F	+15·9	−22·3	−18·4	Star-line faint and seen with difficulty.
				β Tauri.			
Feb.	18 21	4	F	+17·5	− 8·3	− 8·6	Definition poor.
Mar.	3 20	2	F	+18·4	+12·4	+16·7	Spectrum faint, but fairly steady.
	12 21	2	F	+18·5	+ 7·7	+11·7	Star-line seen fairly well.
Apr.	3 21	2	F	+16·8	−32·8	−39·3	Star-line seen fairly well.
				δ Orionis.			
Feb.	18 21	4	F	+16·1	+13·2	+12·8	Star-line seen with great difficulty.
Mar.	12 21	4	F	+17·0	− 6·7	− 6·2	Spectrum faint.
				ε Orionis.			
Mar.	12 21	4	F	+16·9	+ 9·0	+13·7	Spectrum faint and very unsteady.
				ζ Orionis.			
Mar.	12 21	4	F	+16·8	−16·8	−15·5	Star-line faint.
				α Orionis.			
Mar.	17 22	4	b_1	+17·8	+ 4·9	+19·9	Spectrum very unsteady, star-lines seen with great difficulty.
	17 22	4	b_4	+17·8	+19·1	+27·9	
				β Aurigæ.			
Feb.	18 23	2	F	+15·4	−11·6	−10·3	Star-line seen well.
Mar.	3 22	2	F	+16·8	−27·0	−29·7	Star-line very ill-defined.
	12 22	2	F	+17·2	−53·4	−55·2	Spectrum fairly bright, but unsteady.
				γ Geminorum.			
Feb.	18 22	4	F	+14·8	(−10·3)	(−14·8)	Very unsatisfactory. Observations very discordant *inter se.*
Mar.	3 21	2	F	+16·9	+ 7·9	+13·5	Definition fair.
	12 23	2	F	+17·8	−39·5	−48 0	Star-line seen fairly well.
	28 23	4	F	+18·3	−74·1	−80·3	Spectrum bright, but rather unsteady.

Date. 1890. G.C.T.	No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Measd.	Estimd.	Remarks.
			Sirius.			
d h						
Feb. 18 21	4	F	+10·7	− 6·9	− 8·2	Spectrum very unsteady.
Mar. 3 21	6	F	+12·6	− 8·7	− 8·9	Measures very rough.
7 22	4	F	+13·0	−33·5	−34·7	Much cloud. Definition bad.
12 20	6	F	+13·4	−17·6	−18·9	Definition very bad.
Apr. 3 21	2	F	+14·1	−15·8	−18·3	Spectrum very unsteady.
			Castor.			
Feb. 18 22	2	F	+12·3	+38·8	+55·7	Star-line seen fairly well.
Mar. 3 22	2	F	−15·0	+23·8	+31·1	Star-line seen well.
12 23	4	F	+16·4	+ 9·7	+11·2	Spectrum bright and fairly steady.
22 0	2	F	+17·4	+ 3·7	+ 7·1	Star-line seen well.
29 0	2	F	+17·8	− 9·3	− 6·5	Star-line seen well.
Apr. 22 21	2	F	+17·3	+19·6	+28·8	Star-line seen well.
30 21	2	F	+16·6	−10·2	− 5·1	Star-line seen fairly well.
May 23 22	2	F	+12·7	+68·6	+55·2	Spectrum faint.
			Procyon.			
Feb. 18 22	2	F	+10·6	+ 1·4	+14·9	Star-line seen well.
Mar. 3 21	2	F	+13·6	+ 0·5	+11·3	Star-line seen well.
12 23	4	F	+15·2	−29·0	−28·2	Spectrum very unsteady.
21 23	2	F	+16·4	−30·7	−33·3	Star-line seen well.
29 1	4	F	+17·0	−26·9	−28·3	Star-line seen fairly well.
Apr. 22 21	4	F	+17·2	−33·5	−29·8	Star-line seen well.
30 21	2	F	+16·7	−12·0	− 7·5	Star-line seen fairly well.
			Pollux.			
Feb. 18 22	2	F	+11·6	−23·1	−21·8	Star-line seen with difficu'ty.
Mar. 3 21	2	F	+14·6	−23·7	−25·7	Star-line seen with great difficulty.
12 23	2	F	+16·1	−52·7	−67·9	Star-line seen fairly well.
17 23	2	b_1	+16·7	−27·6	−34·1	Star-lines seen with great difficulty.
22 0	2	F	+17·2	−68·4	−73·6	Star-line seen well.
29 0	2	F	+17·8	−53·7	−57·3	Star-line seen with difficulty.
Apr. 22 21	2	F	+17·7	−49·2	−47·6	Star-line seen fairly well.
30 21	2	F	+17·0	−61·6	−53·8	Measures made with difficulty.
May 23 22	2	F	+13·4	−61·4	−59·2	Star-line seen well.

Date. 1890. G.C.T.		No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Measd.	Estimd.	Remarks.
				Regulus.			
d	h						
Mar. 22	1	2	F	+10·1	−10·9	−10·1	Cloud passing. Measures rough.
29	1	2	F	+11·8	+17·1	+21·1	Star-line seen well.
Apr. 22	21	4	F	+16·3	− 0·5	+ 7·5	Star-line seen well.
30	22	2	F	+17·2	−55·6	−49·4	Star-line faint.
May 17	22	1	F	+17·9	+ 9·7	+18·7	Spectrum bright and steady. Star-line seen well.
21	22	2	F	+17·9	−66·1	−67·9	Measures made with difficulty.
23	22	2	F	+17·8	−12·1	−12·7	Star-line seen well.
June 2	22	2	F	+17·4	−16·2	−15·4	Observations interrupted by cloud.
				γ Leonis.			
Mar. 29	1	2	F	+11·8	−15·9	−17·5	Star-line faint and difficult to see.
Apr. 22	22	2	F	+16·2	−28·1	−25·4	Star-line faint and difficult to see.
30	22	2	F	+17·1	−44·8	−44·0	Star-line very faint.
May 21	22	2	F	+17·7	−27·1	−26·3	Star-line faint and difficult to see.
23	22	2	F	+17·6	−18·4	− 7·4	Star-line very faint. Measures rough.
				β Ursæ Majoris.			
May 7	23	2	F	+12·7	−71·5	−58·7	Star-line ill-defined.
				α Ursæ Majoris.			
May 8	0	2	F	+11·6	−46·2	−46·1	Measures very rough.
Sept. 15	22	2	h_1	− 7·5	(+50·5)	(+56·8)	Star-line very faint and seen with great difficulty.
				β Leonis.			
Mar. 29	2	2	F	+ 5·6	+20·7	+22·6	Star-line seen fairly well.
Apr. 22	22	2	F	+12·0	+13·5	+24·8	Star-line seen fairly well.
30	22	2	F	+13·6	−20·0	−19·4	Star-line seen fairly well.
May 21	22	2	F	+16·5	− 4·2	− 7·9	Star-line seen with difficulty.
23	23	2	F	+16·7	+18·7	+30·0	Spectrum unsteady. Star-line very difficult to bisect.
				γ Ursæ Majoris.			
May 7	23	2	F	+12·0	−35·9	−36·6	Star-line ill-defined.
				δ Ursæ Majoris.			
May 7	23	2	F	+10·9	+ 6·0	+16·7	Star-line ill-defined.

Date. 1890. G.C.T.		No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Measd.	Estimd.	Remarks.
				ε Ursæ Majoris.			
	d h						
May	7 22	2	F	+ 9·9	−56·0	−50·9	Star-line seen fairly well.
				Spica.			
Apr.	22 22	2	F	+ 3·3	+19·8	+23·6	Star-line seen fairly well.
	30 23	2	F	+ 5·6	−28·1	−28·6	Star-line seen fairly well.
May	12 22	1	F	+ 8·9	−53·6	−54·9	Observations interrupted by cloud.
	15 22	4	F	+ 9·7	−59 1	−53·1	Star-line seen fairly well.
	21 23	2	F	+11·1	+26·6	+24·7	Measures made with great difficulty.
	23 23	2	F	+11·6	−66·4	−67·6	Star-line seen well.
	31 23	4	F	+13·3	−63·5	−49·8	Star-line seen well.
				ζ Ursæ Majoris.			
May	7 22	2	F	+ 8·9	−44·9	−54·9	Star-line ill-defined.
				η Ursæ Majoris.			
May	7 22	2	F	+ 8·2	−17·5	−22·0	Star-line ill-defined.
				Arcturus.			
Mar.	18 0	4	b_1	− 6·8	−28·6	−36·7	Spectrum very unsteady. Star-line distinct.
Apr.	22 22	2	F	+ 2·7	−26·6	−29·6	Star-line seen fairly well.
	30 23	4	F	+ 4·8	−37·2	−41·2	Star-line seen fairly well.
May	5 22	2	F	+ 5·9	−33·4	−34·8	Star-line very faint.
	7 21	2	F	+ 6·4	−31·6	−31·0	Star-line faint.
	15 22	2	F	+ 8·2	−40·4	−42·5	Star-line faint and seen with difficulty.
	21 23	2	F	+ 9·5	−45·5	−43·8	Star-line seen well.
	23 23	2	F	+ 9·9	−57·5	−60·8	Star-line seen fairly well.
	31 23	2	F	+11·3	−40·5	−37·0	Star-line seen fairly well.
June	27 23	2	F	+14·6	−37·7	−30·9	Star-line seen well now and then.
July	3 22	2	F	+15·0	−36·3	−35·5	Star-line seen with difficulty.
Aug.	6 22	2	F	+14·3	−55·0	−57·2	Star-line seen with great difficulty.
Sept.	15 21	4	b_1	+ 7·8	(−64·7)	(−62·0)	Spectrum faint and very unsteady.
				β Ursæ Minoris.			
Sept.	15 22	2	b_1	− 3·5	(−44·2)	(−40·9)	Star-line seen with great difficulty.

Date. 1890. G.C.T.		No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Measd.	Estimd.	Remarks.
				β Libræ.			
	d h						
Apr.	22 23	2	F	− 4·7	−16·6	−20·6	Star-line seen fairly well.
May	1 0	2	F	− 2·3	+ 6·7	+ 6·9	Star-line seen well.
	15 22	4	F	+ 2·2	−38·0	−40·3	Star-line seen well.
	24 0	2	F	+ 4·5	−22·9	−22·4	Star-line seen well.
	31 23	2	F	+ 6·8	−53·4	−47·4	Star-line seen fairly well.
June	6 23	2	F	+ 8·3	−47·5	−71·9	Star-line faint.
				α Coronæ Borealis.			
Apr.	22 23	4	F	− 1·8	+31·6	+36·3	Star-line seen fairly well.
May	15 23	2	F	+ 3·2	+35·1	+38·0	Star-line seen well.
	22 0	2	F	+ 4·4	+18·7	+17·1	Star-line seen well.
	24 0	2	F	+ 4·8	+25·3	+30·8	Star-line seen well.
	31 23	2	F	+ 6·3	+ 8·6	+ 5·9	Star-line seen fairly well.
June	27 23	2	F	+10·5	−10·9	− 6·3	Star-line seen fairly well.
July	3 22	2	F	+11·1	−16·6	−13·9	Star-line seen fairly well.
Aug.	6 22	2	F	+12·8	−78·4	−63·7	Spectrum faint and very unsteady. Star-line exceedingly ill-defined.
Sept.	8 21	2	F	+10·6	−26·9	−23·5	Star-line seen well.
				α Ophiuchi.			
Apr.	30 23	4	F	− 9·5	−17·4	−10·8	Star-line very broad and diffused.
May	15 23	4	F	− 6·4	− 9·9	− 7·3	Star-line very broad and diffused.
	22 0	2	F	− 5·0	− 6·1	− 7·9	Star-line seen fairly well.
	24 0	2	F	− 4·5	−13·3	−12·5	Star-line broad and diffused.
	31 24	2	F	− 2·6	−19·2	−17·7	Star-line seen fairly well.
June	7 0	2	F	− 1·2	−10·8	−10·2	Star-line seen fairly well.
	27 23	2	F	+ 3·8	−26·0	−20·6	Star-line seen well.
July	3 23	2	F	+ 5·2	−38·9	−36·0	Star-line unusually broad and diffused.
Aug.	1 22	2	F	+10·9	−46·3	−32·1	Definition poor.
	6 23	2	F	+11·6	−47·5	−43·4	Spectrum faint. Star-line ill-defined.
Sept.	8 22	2	F	+14·7	−35·1	−38·8	Star-line very ill-defined and difficult to observe.
				Vega.			
May	1 0	2	F	− 7·7	−30·8	−26·1	Star-line seen well.
	15 23	2	F	− 6·4	− 3·7	− 2·7	Star-line very broad and diffused.

Date. 1890. G.C.T.	No. of Meas.	Line.	Earth's Motion in miles per sec.	Concluded Motion of Star. Measd.	Estimd.	Remarks.
			Vega (continued).			
May 22 1	2	F	− 5·8	−53·1	−51·3	Star-line seen well.
24 0	2	F	− 5·6	−10·1	−12·3	Star-line seen well.
June 1 0	2	F	− 4·7	−25·5	−21·7	Star-line seen well.
July 3 23	2	F	− 0·3	−63·1	−46·3	Star-line seen well.
Aug. 1 23	2	F	+ 3·7	− 8·0	− 8·6	Star-line seen well.
6 23	2	F	+ 4·3	−10·4	− 9·1	Star-line seen fairly well.
Sept. 8 22	2	F	+ 7·6	−26·0	−18·3	Spectrum bright but unsteady.
13 21	2	F	+ 7·9	−24·6	−25·8	Star-line seen well.
24 21	4	F	+ 8·5	−34·8	−34·4	Cloud passing.
Oct. 1 21	2	F	+ 8·7	−14·5	− 8·7	Definition bad.
3 21	2	F	+ 8·7	−21·0	−23·5	Definition fair.
9 20	2	F	+ 8·7	−45·0	−41·8	Star-line seen fairly well.
11 21	2	F	+ 8·7	−41·5	−34·9	Definition bad.
16 19	4	F	+ 8·6	−37·5	−31·6	Definition poor. Wind high.
			γ Lyræ.			
Aug. 1 23	2	F	+ 3·4	+ 7·5	+11·3	Star-line seen fairly well.
6 23	2	F	+ 4·2	−16·2	−13·7	Star-line seen fairly well.
Sept. 13 21	2	F	+ 9·1	−29·8	−15·9	Spectrum extremely faint.
			ζ Aquilæ.			
Aug. 1 23	2	F	+ 5·2	− 7·7	− 5·2	Star-line seen fairly well.
6 23	2	F	+ 6·3	−13·7	−11·1	Star-line seen with difficulty.
Sept. 13 21	2	F	+13·0	+10·4	+10·0	Spectrum extremely faint.
			δ Cygni.			
Aug. 7 0	2	F	0·0	−70·7	−52·5	Star-line faint and ill-defined.
Sept. 13 21	2	F	+ 4·6	+ 8·6	+22·6	Star-line seen fairly well.
			Altair.			
May 16 0	2	F	−14·2	− 5·2	− 1·8	Star-line seen well.
24 0	2	F	−13·2	−20·7	−19·0	Star-line seen well.
June 1 0	2	F	− ·9	−10·0	− 8·4	Star-line seen well.
28 0	2	F	− 6·3	−47·0	−27·2	Star-line seen well.
July 3 23	2	F	− 4·9	−57·4	−41·7	Star-line seen fairly well.
Aug. 1 22	2	F	+ 2·5	−45·2	−46·5	Star-line seen well.
4 22	2	F	+ 3·3	−44·2	−39·2	Star-line seen fairly well.
6 23	2	F	+ 3·8	−72·9	−70·6	Star-line seen fairly well.
Sept. 8 22	2	F	+11·4	−32·4	−30·1	Star-line seen well.
13 22	2	F	+12·3	−30·8	−40·4	Star-line seen fairly well.

Date. 1890. G.C.T.		No. of Meas.	Line.	Earth's Motion in Miles per sec.	Concluded Motion of Star. Measd	Estimd.	Remarks.
				Altair (continued).			
	d h						
Oct.	1 22	2	F	+14·9	−35·3	−31·5	Definition bad.
	3 21	2	F	+15·1	−56·4	−51·3	Definition fair.
	9 21	2	F	+15·6	−44·0	−38·1	Star-line seen fairly well.
	11 21	2	F	+15·8	−76·6	−55·1	Definition bad.
	16 20	2	F	+16·1	−45·0	−37·6	Definition bad. Observations interrupted by cloud.
				γ Cygni.			
Oct.	11 21	2	F	+ 8·2	−51·2	−41·5	Definition bad.
				α Cygni.			
May	16 0	2	F	− 8·9	−51·2	−41·4	Star-line seen fairly well.
July	3 23	1	F	− 7·0	−42·4	−48·8	Observations interrupted by cloud.
Aug.	4 22	2	F	− 3·3	−64·8	−66·0	Star-line seen fairly well.
Sept.	8 23	2	F	+ 1·9	−47·8	−42·0	Spectrum bright and steady.
	13 22	2	F	+ 2·7	−28·5	−41·0	Spectrum fairly bright and steady.
Oct.	1 22	2	F	+ 5·3	− 4·7	− 5·3	Definition bad.
	3 22	2	F	+ 5·5	−36·6	−31·8	Star-line seen fairly well.
	9 21	2	F	+ 6·3	−42·3	−43·9	Star-line seen fairly well.
	11 21	2	F	+ 6·5	−33·9	−23·4	Definition poor.
				α Cephei.			
May	16 0	2	F	− 4·5	−38·1	−29·1	Star-line seen well.
Aug.	1 23	2	F	− 5·6	−87·8	−92·2	Star-line seen with the utmost difficulty.
Oct.	11 22	2	F	+ 0·8	−26·6	−19·9	Definition very bad.
	16 20	2	F	+ 1·4	−16·9	−16·1	Observing position very awkward.
				α Pegasi.			
Aug.	2 0	2	F	−11·3	−29·6	−27·°	Star-line seen fairly well.
	7 0	2	F	−10·0	−28·0	−25·8	Star-line seen fairly well.
Sept.	8 23	2	F	− 1·7	−21·9	−19·7	Star-line faint and seen with difficulty.
	11 23	2	F	− 0·9	−43·8	−47·5	Star-line seen well.
	13 22	4	F	− 0·3	+22·1	+20·3	Star-line seen fairly well.
Oct.	1 22	2	F	+ 5·0	−24·6	−23 0	Definition poor.
	9 21	2	F	+ 7·2	−19·5	−26·8	Star-line seen fairly well.
	11 22	2	F	+ 7·8	−27·4	−23·3	Definition poor.

Date. 1890. G.C.T.		No. of Meas.	Line.	Earth's Motion in Miles per sec.	Concluded Motion of Star. Measd.	Estimd.	Remarks.
				Mars.			
d	h						
May 31	23	2	F	...	− 2·0	0·0	Calculated motion −0·8.
June 7	0	2	F	...	− 6·1	0·0	Calculated motion +0·3.
				Great Nebula in Orion.			
Mar. 17	20	7	N_1	+16·2	− 7·4	...	Compared with Nitrogen. Observations too rough to give a satisfactory determination of displacement. Resulting wave-length of nebular line λ 5005·0, assuming that of the nitrogen as λ 5005·2.
				Moon.			
Mar. 3	22	5	F	...	− 2·3	...	
28	23	5	F	...	− 2·4	...	
Apr. 30	22	5	F	...	+ 1·1	...	
May 5	22	5	F	...	+ 2·2	...	
23	22	5	F	...	− 1·3	...	The coincidence of the lines in the two spectra appeared perfect.
31	23	5	F	...	+ 1·7	...	
June 27	23	5	F	...	+ 1·2	...	
July 3	23	5	F	...	+ 2·6	...	
Aug. 2	0	5	F	...	+ 2·2	...	
7	1	5	F	...	− 2·2	...	
				Sun.			
May 16	12	5	F	...	+ 1·1	...	The coincidence of the lines in the two spectra appeared perfect.
				Sky.			
Mar. 14	12	5	F	...	− 2·9	...	
18	12	5	b_1	...	+ 1·0	...	The coincidence of the lines in the two spectra appeared perfect.
Sept. 10	12	5	F	...	+ 1·0	...	
15	11	5	F	...	+ 3·5	...	
17	12	5	b_1	...	− 8·6	...	The sky spectrum was found to be displaced towards the blue by a very small but unmistakable amount.

Observations of Occultations of Stars by the Moon and of Phenomena of Jupiter's Satellites, made at the Royal Observatory, Greenwich, in the year 1890.

(*Communicated by the Astronomer Royal.*)

Occultations of Stars by the Moon.

Day.	Phenomenon.	Telescope.	Power.	Moon's Limb.	Mean Solar Time of Observation. h m s	Observer.
1890 Jan. 15 (*a*)	Reapp. o^1 Libræ	Simms' No. 1	75	Dark	16 31 6·25	A. M.
Feb. 7 (*b*)	Disapp. ν Virginis	Lassell Refl.	280	Bright	11 6 7·08	L.
7 (*c*)	,, ν Virginis	E. Equat.	140	,,	11 6 6·12	H.
7	,, ν Virginis	Altaz.	100	,,	11 6 3·41	S. D.
7	Reapp. ν Virginis	,,	100	Dark	12 19 59·83	L.
7	,, ν Virginis	E. Equat.	140	,,	12 19 59·92	H.
Mar. 29 (*d*)	Disapp. 7 Cancri	Altaz.	100	,,	13 10 18·63	T.
Apr. 7 (*e*)	Reapp. ζ^1 Libræ	,,	100	,,	15 28 9·84	J. P.
7	,, ζ^1 Libræ	E. Equat.	70	,,	15 28 9·07	W.R.
30	Disapp. ν Virginis	E. Equat.	140	,,	10 58 12·83	H.
30	,, ν Virginis	Altaz.	100	,,	10 58 12·98	S. D.
30	Reapp. ν Virginis	,,	100	Bright	11 48 22·97	S. D
May 3	Disapp. 95 Virginis	E. Equat.	140	Dark	8 50 23·13	A. D.
3	,, κ Virginis	Altaz.	100	,,	13 7 31·36	H. T.
3	,, κ Virginis	E. Equat.	140	,,	13 7 31·36	A. D.
June 2 (*f*)	,, ω Ophiuchi	Altaz.	100	Bright	10 5 51·28	H. T.
2 (*g*)	,, ω Ophiuchi	E. Equat.	210	,,	10 5 54·96	A. D

Day.	Phenomenon.	Telescope.	Power.	Moon's Limb.	Mean Solar Time of Observation. h m s	Observer.
1890 June 29 (*i*)	Disapp. β^2 Scorpii	E. Equat.	60	Bright	9 59 37·12	L.
29	Reapp. β^2 Scorpii	,,	60	Dark	11 12 1·88	L.
29	,, β^1 Scorpii	,,	60	,,	11 12 3·98	L.
Sept. 6	,, Piazzi v. 192	,,	70	,,	12 41 58 48	W. R.
20	Disapp. 24 Ophiuchi	Altaz.	100	,,	7 54 31·36	J. P.
20	,, 24 Ophiuchi	E. Equat.	70	,,	7 54 31·14	A. D.
27 (*i*)	,, 30 Piscium	Altaz.	100	,,	10 36 9·98	H. F.
27 (*k*)	,, 33 Piscium	E. Equat.	140	,,	12 30 54·72	H.
Oct. 27 (*l*)	,, ξ^1 Ceti	Lassell Refl.	280	,,	7 22 33·00	H. T.
27	,, ξ^1 Ceti	E. Equat.	140	,,	7 22 33·64	H.
27 (*m*)	,, ξ^1 Ceti	Altaz.	100	,,	7 22 32·74	S. D.
27 (*n*)	Reapp. ξ^1 Ceti	E. Equat.	140	Bright	8 21 46·19	H.
27 (*o*)	,, ξ^1 Ceti	Altaz.	100	,,	8 21 (56·57)	S. D.

Notes.

(*a*) Cloudy.
(*b*) Star seemed to hang on limb for 1^s.
(*c*) Star appeared to *glide* behind Moon's limb; the disappearance had a perceptible duration; the time of last contact was noted.
(*d*) Star faint.
(*e*) Instantaneous.
(*f*) Clouds began to sweep over about 4^s before time of observation, but it is believed that the true occultation was observed, the star being close to the Moon's limb.
(*g*) Clouds passing.
(*i*) Cloudy; doubtful whether occulted by Moon or cloud.
(*k*) Moon's limb nearly full. Star did not seem to disappear instantaneously, but gradually faded away.
(*l*) Star disappeared into Moon's rough limb.
(*m*) Star very faint.
(*n*) Observation not considered good; perhaps late.
(*o*) Star some distance from Moon's limb when first seen.

Phenomena of Jupiter's Satellites.

Day.	Satellite.	Phenomenon.	Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1890 June 19	III.	Ecl. R. First seen	E. Equat.	210	12 43 57	12 44 19	H. T
19	III.	Occ. D. First contact	,,	,,	12 51 31	12 53	,,
19	III.	Last seen	,,	,,	12 55 45		,,
July 19 (*a*)	II.	Tr. Ing. First contact	,,	,,	12 12 40		W. R.
19	II.	Bisection	,,	,,	12 13 58	12 14	,,
19	II.	Last seen	,,	,,	12 16 6		,,
26	I.	Tr. Ing. First contact	Altaz.	100	9 17 29	9 21	L.
26	I.	Last seen	,,	,,	9 22 35		,,
26	III.	Tr. Egr. First seen	E. Equat.	140	11 35 50		,,
26	III.	Bisection	,,	,,	11 37 53	11 41	,,
26	III.	Last contact	,,	,,	11 40 14		,,
28	II.	Occ. R. First seen	Altaz.	100	11 36 4	11 37	S. D.
Aug. 1	III.	Occ. D. First contact	E. Equat.	60	8 52 51	8 55	T.
1	III.	Last seen	,,	,,	8 57 6		,,
1	III.	Ecl. R. First seen	,,	210	12 44 48		T.
1	III.	First seen	Altaz.	100	12 44 2	12 45 54	H. F.
1	III.	Full brightness	,,	,,	12 46 11		,,
1	I.	Occ. D. First contact	E. Equat.	210	13 54 11	13 56	T.
1	I.	Last seen	,,	,,	13 57 46		,,

Day.		Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1890 Aug.	3 (*b*)	I.	Ecl. R.	First seen	E. Equat.	210	10 47 22	10 46 44	T.
	4 (*c*)	II.	Occ. D.	Last seen	,,	,,	10 55 46		H.
	4	II.		First contact	Altaz.	100	10 55 47	10 56	H. F.
	4	II.		Last seen	,,	,,	10 59 18		,,
	18	I.	Tr. Ing.	First contact	E. Equat.	140	8 56 15		L.
	18	I.		Bisection	,,	,,	8 58 20	8 58	,,
	18	I.		Last seen	,,	,,	9 0 36		,,
	22 (*a*)	II.	Ecl. R.	First seen	,,	210	8 33 40	8 33 28	T.
	29	III.	Ecl. R.	First seen	Altaz.	100	11 8 4	11 9 41	S. D.
	29	III.		First seen	E. Equat.	70	11 9 26		A. M.
Sept.	9 (*d*)	I.	Occ. D.	First contact	,,	140	11 34 52	11 36	L.
	9	I.		Last seen	,,	,,	11 36 52		,,
	10	I.	Tr. Ing.	First contact	,,	70	8 41 2	8 44	H.
	10	I.		Last seen	,,	,,	8 44 46		,,
	10	I.	Tr. Egr.	First seen	,,	,,	11 0 29	11 4	,,
	10	I.		Last contact	,,	,,	11 7 48		,,
	11	I.	Ecl. R.	First seen	,,	,,	9 20 23	9 19 40	H. F.
	12	II.	Occ. D.	First contact	,,	210	11 27 36		A. D.
	12	II.		Bisection	,,	,,	11 29 40	11 31	,,
	12	II.		Last seen	,,	,,	11 32 25		,,

Day.	Satellite.	Phenomenon.	Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1890 Sept. 13	III.	Occ. R. First seen	Tr. Circle	195	8 48 57	8 51	L.
13 (*e*)	III.	Ecl. D. Last seen	E. Equat.	140	9 17 36	9 18 41	,,
19 (*f*)	I.	Tr. Egr. First contact	Altaz.	100	7 15 54	7 20	,,
20 (*g*)	III.	Occ. D. First contact	E. Equat.	210	8 35 59		A. D.
20	III.	Bisection	,,	,,	8 42 18	8 47	,,
20	III.	Last seen	,,	,,	8 48 22		,,
23 (*h*)	II.	Ecl. R. First seen	Lassell Refl.	280	8 20 14		L.
23 (*i*)	II.	Full brightness	,,	,,	8 21 51	8 18 11	,,
23 (*k*)	II.	First seen	E. Equat.	140	8 18 15		H.
23	II.	Full brightness	,,	,,	8 20 9		,,
24	IV.	Occ. R. Last contact	,,	,,	9 28 43	9 32	A. D.
24	IV.	Last contact	Altaz.	100	9 29 55		W. R.
25 (*l*)	I.	Occ. D. Last seen	E. Equat.	140	9 34 13	9 42	H.
27 (*h*)	I.	Ecl. R. First seen	,,	,,	7 39 17	7 39 4	,,
27	I.	Full brightness	,,	,,	7 41 33		,,
Oct. 3	I.	Tr. Ing. First contact	,,	,,	8 37 28		,,
3	I.	Bisection	,,	,,	8 41 38		,,
3	I.	Last seen	,,	,,	8 44 42	8 41	,,
3	I.	First contact	Altaz.	100	8 37 59		W. R.
3	I.	Last seen	,,	,,	8 45 38		,,

Day.	Satellite.	Phenomenon.	Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1890 Oct. 11	I.	Occ. D. First contact	Lassell Refl.	280	7 50 46		L.
11	I.	Last seen	,,	,,	7 55 1		,,
11 (*m*)	I.	First contact	E. Equat.	70	7 52 45	7 54	H. F.
11	I.	Bisection	,,	,,	7 54 16		,,
11	I.	Last seen	,,	,,	7 56 26		,,
12	I.	Tr. Egr. First seen	Lassell Refl.	280	7 19 25		A. D.
12	I.	Bisection	,,	,,	7 21 35	7 22	,,
12	I.	Last contact	,,	,,	7 23 40		,,
27	I.	Occ. D. First contact	,,	,,	6 10 7		H. T.
27	I.	Last seen	,,	,,	6 13 33	6 11	,,
27	I.	Last seen	E. Equat.	140	6 13 17		H.
28 (*n*)	I.	Tr. Egr. Last contact	,,	,,	5 43 10	5 41	L.
28 (*h*)	IV.	Ecl. R. First seen	,,	,,	8 36 16	8 41 40	,,
28	IV.	Full brightness	,,	,,	8 38 46		,,
Nov. 4 (*o*)	I.	Tr. Ing. First contact	Altaz.	100	5 15 16	5 17	W. R.
4	I.	Last seen	,,	,,	5 20 55		,,
5 (*h*)	I.	Ecl. R. First seen	Lassell Refl.	289	6 14 35	6 13 31	L.
5 (*p*)	I.	Full brightness	,,	,,	6 17 38		,,
5 (*q*)	IV.	Tr. Egr. Last contact	,,	,,	6 25 23	6 39	,,

Day.	Satellite.	Phenomenon.	Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1890 Nov. 17	I.	Tr. Ing. First contact	Altaz.	100	5 32 52		A. D.
17	I.	Bisection	,,	,,	5 39 21		,,
17	I.	Last seen	,,	,,	5 44 0		,,
17	I.	First contact	E. Equat.	70	5 37 25	5 35	H.
17	I.	Bisection	,,	,,	5 40 15		,,
17	I.	Last seen	,,	,,	5 42 54		,,

Notes.

(*a*) *Jupiter* very ill-defined. (*b*) Diffused. (*c*) Observation not considered good; power too high.

(*a*) Cloudy directly afterwards.

(*d*) Satellite scarcely visible, times necessarily rough. Last contact may have been really obscuration by cloud.

(*e*) Image bad; observation not considered good.

(*f*) Cloudy; observation very doubtful.

(*g*) *Jupiter* very tremulous and ill-defined.

(*h*) Observation considered good. (*i*) Uncertain to quite 20ˢ. (*k*) Definition good.

(*l*) Sky misty; satellite very faint; *Jupiter* ill-defined. The satellite seemed to merge in the limb at the time noted and was no more seen.

(*m*) Definition bad. (*n*) *Jupiter* very ill-defined; foggy. (*o*) Satellite faint; twilight. (*p*) Thin cloud, observation rough.

(*q*) The first contact was perhaps $6^h\ 19^m$ when the satellite was glimpsed for a few seconds. There can be no doubt about last contact. The satellite was followed till $6^h\ 45^m$; at $6^h\ 30^m$ it was right away from *Jupiter*.

The clear aperture of the mirror of the Lassell Reflector is 24 inches, of the object-glass of the Transit Circle 8·1 inches, of the E. Equatorial 6·7 inches, of the Altazimuth $3\frac{3}{4}$ inches, and of the Simms' No. 1, 3 6 inches.

The initials H. T., A. D., T., L., H., J. P., S. D., W. R., H. F., and A. M., are those of Mr. Turner, Mr. Downing, Mr. Thackeray, Mr. Lewis, Mr. Hollis, Mr. Power, Mr. Dolman, Mr. Russell, Mr. Furner, and Mr. Miskin respectively.

Royal Observatory, Greenwich:
1891 *January* 1.

Errata in Greenwich Observations of Comet a 1890 (*Brooks*).

(*Communicated by the Astronomer Royal.*)

Monthly Notices, vol. l. p. 528.

Greenwich Mean Solar Time of Observation, 1890.

	d	h	m	s		d	h	m	s
for Aug.	4	10	13	13 6	*read* Aug.	4	10	14	13
,,		10	21	9 0	,,		10	22	9
,,		10	29	4·3	,,		10	30	4
,,	15	10	25	41·0	,,	15	10	26	41
,,		10	28	24·1	,,		10	29	24
,,		10	32	28·6	,,		10	33	29

Monthly Notices, vol. li. p. 49.

Greenwich Mean Solar Time of Observation, 1890.

	d	h	m	s		d	h	m	s
for Sept.	14	8	22	58	*read* Sept.	14	8	23	48
,,		8	33	57	,,		8	34	37
,,		8	33	57	,,		8	34	37
,,	15	8	3	30	,,	15	8	4	29
,,		8	27	16	,,		8	28	16
,,		8	48	2	,,		8	49	2
,,		8	48	2	,,		8	49	2

The comparisons of the clock Earnshaw (by which the times of observation were recorded) with the Sidereal Standard Clock were found to be 1^m in error from 1890 July 2 to Sept. 22. A mistake of 1^m in the computed time of one of the observations on September 14 has also been found.

Royal Observatory, Greenwich:
1891 *January* 14.

Note on the Recent Determination of the Longitude of Paris.

By H. H. Turner, M.A., B.Sc.

In the year 1887 a request was made to the Astronomer Royal by the officers of the French Geodetic Survey that the longitude Paris-Greenwich should be redetermined with all the accuracy attainable by modern methods. This longitude was determined telegraphically under the direction of M. Le Verrier and Sir George Airy in 1854, both stars and signals being observed by the eye and ear method. The observers were M. Faye, of the Paris Observatory, and Mr. Dunkin, of the Greenwich Observatory, who were interchanged once. The instruments used were the large transit circles of the two observatories. The result found for the difference of longitude between the Greenwich transit-circle and the meridian of Cassini (Paris) was $9^m\ 20^s{\cdot}51$; and the accordance of the twelve nights of observation was remarkably good: it was quoted by Sir George Airy, in a letter to Sir John Herschel, as sufficient to justify the adoption of the final result, although this differed by about 1^s from the previously-assumed longitude, $9^m\ 21^s{\cdot}57$, determined by rocket signals in July, 1825. (*Phil. Trans.* 1826, Part II.)

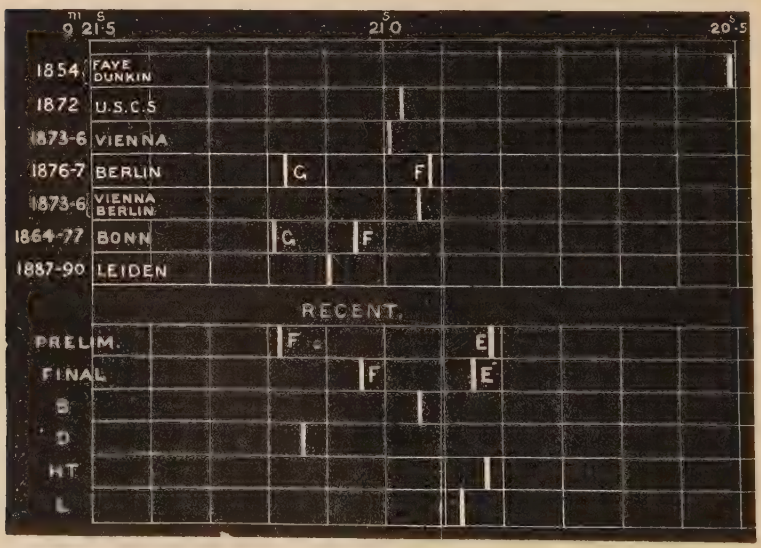
But there has since been reason to doubt the correctness of this result. In 1872 the same longitude was found by J. E. Hilgard, of the U.S. Coast Survey, to be $9^m\ 20^s{\cdot}97$ (U.S. Coast Survey: Report for 1872); and since then various indirect determinations (such as the combination of the longitude Vienna-Greenwich with Paris-Vienna) have indicated that the result of 1854 is too small. The following is a list of all telegraphic determinations published up to 1888:—

Longitude Paris (Cassini's meridian)—Greenwich (Transit Circle).

	Result.	Date.	Reference.
I. Direct.			
Paris-Greenwich	m s 9 20·51	1854	*Monthly Notices, R.A.S.* vol. xv. p. 124 (reduced to Cassini's meridian).
Paris-Greenwich	9 20·97	1872	U.S. Coast Survey, 1874, p. 180 (reduced to Cassini's meridian).
II. Indirect.			
Vienna-Greenwich	65 21·21	1876	Assoc. Géodésique. Report on Longitude, by Bruhns (1880).
Paris-Vienna	56 0·22	1873	
Paris-Greenwich	9 20·99		
Berlin-Greenwich	53 34·91	1876	Assoc. Géodés. (1883). Report by Bakhuyzen.
Paris-Berlin (F.)	44 13·99	1877	Comptes Rend. 1878, Feb. 4.
Paris-Greenwich (F.)	9 20·92		

	Result. m s	Date.	Reference.
Berlin-Greenwich	53 34·91	1876	*ut supra.*
Paris-Berlin (G.)	44 13·75	1877	Pub. Preuss. Geodät. Institut. 1877, p. 147.
Paris-Greenwich (G.)	9 21·16		
Vienna-Berlin	11 46·26	1876	Assoc. Géodés. (1883).
Berlin-Greenwich	53 34·91	1876	Assoc. Géodés. (1883).
Paris-Vienna	−56 0·22	1873	*ut supra.*
Paris-Greenwich	9 20·95		
Bonn-Greenwich	28 23·31	1864	Assoc. Géodés. (1880).
Paris-Bonn (F.)	19 2·26	1877	Assoc. Géodés. (1880).
Paris-Greenwich (F.)	9 21·05		
Bonn-Greenwich	28 23·31	1864	
Paris-Bonn (G.)	19 2·12	1877	Pub. Pr. Geod. Inst. (1877)
Paris-Greenwich (G.)	9 21·19		
Greenwich-Leiden	17 56·30	1880	Assoc. Géodés. (1883).
Paris-Leiden	8 35·21		Provisional.
Paris-Greenwich	9 21·09		

The determinations Paris-Berlin and Paris-Bonn in 1877 were made independently by French and German observers, whose results are distinguished in the above table by the letters (F.) and (G.) A comprehensive view of these results is afforded by the upper portion of the subjoined diagram.



It is thus apparent that a direct redetermination of this longitude was a matter of great interest and importance. The Astronomer Royal accordingly entered into communication with the late General Perrier, then Director of the "Service Géographique de l'Armée Française," and with Admiral Mouchez, the Director of the Paris Observatory, as to the programme of observations and the date on which the operations could be commenced. It was decided that the summer of 1888 should be devoted to the work; and at this point negotiations were interrupted by the sudden and lamented death of General Perrier, on February 20, 1888. They were shortly afterwards renewed by Col. Derrècagaix, General Perrier's successor. It was arranged that M. Loewy (representing the Paris Observatory and the Bureau des Longitudes) and Commandants Bassot and Defforges (representing the Service Géographique) should pay a visit to Greenwich and settle the definitive programme in consultation with the Astronomer Royal. This visit was paid on June 15, 1888, and following days. M. Loewy reported that the Paris Observatory would not be able to take part in the work, which would thus be shared by the French Service Géographique and the Royal Observatory, Greenwich. It was decided that two observers should be appointed by each of these; and that the French observers should be Commt. Bassot (B) and Commt. Defforges (D); and the English Mr. Turner (H T) and Mr. Lewis (L). B and D were to use two French portable transit instruments by Brunner Bros., such as they had already used for other longitudes; and H T and L two of the portable transits by Troughton and Simms in the possession of the Greenwich Observatory. The observers were to be interchanged twice as follows:—

1st Series: 3 full nights, or the equivalent in half-nights.
D and L at Greenwich, B and H T at Paris.
2nd Series: 3 full nights, or equivalent.
B and H T at Greenwich, D and L at Paris.
3rd Series: 3 full nights, or equivalent.
B and H T at Greenwich, D and L at Paris.
4th Series: 3 full nights, or equivalent.
D and L at Greenwich, B and H T at Paris.

All four observers were to exchange signals automatically on their respective chronographs each night [in the order B and D, B and L, H T and L, H T and D for the 1st and 4th series, and the order D and B, D and H T, L and H T, L and B for the 2nd and 3rd series], so as to give 4 determinations of personal equation, two and two, and to eliminate small differences in the two chronographs at each station. Later in each complete evening the exchanges B—D and H T—L only were to be repeated, so that the mean epoch of these pairs of exchanges should be nearly the same as that of the time-determinations. The Paris station was at the Observatoire du Dépôt de la Guerre, Montsouris, where one French and one English instru-

ment were mounted on two piers 12 feet apart, the English instrument being to the east; and the Greenwich station the front court of the Royal Observatory, where two transit-huts were erected and two piers built, that for the French instrument being 41 feet, and that for the English instrument being 19 feet, west of the transit-circle. The four chronographs were kindly lent by the French Service Géographique, and had been in use for other longitude operations. A spare wire was courteously placed at the disposal of the Astronomer Royal each night from eight to twelve by the Submarine Telegraph Company; and the French and English Post Offices provided the services of clerks at Montsouris and Greenwich during these hours, and the use of wires from Paris to Calais and from Greenwich to London, so as to give direct communication between Montsouris and Greenwich. Operations were commenced on September 21, 1888, when Commt. Defforges arrived at Greenwich to co-operate in preparing the galvanic connections and to mount his instrument. Mr. Turner left for Paris on September 23. The following is an account of the course of the work, P denoting Paris and G Greenwich:—

September 25.—Cloudy P and G: exchange of practice signals.
September 26.—Cloudy P and G.
September 27.—Partly clear: instruments adjusted to meridian.
September 28.—Cloudy P and G.
September 29.—Cloudy P and G.
September 30.—Partly clear: one exchange: half-night.
October 1.—Partly clear: one exchange: half-night.
October 2.—Clear G: cloudy P.
October 3.—Partly clear: one exchange: half-night.
October 4.—Cloudy P and G.
October 5.—Quite clear P and G: two complete exchanges: full night.

(End of 1st Series.)

October 6.—H T returned to Greenwich. Clear G: cloudy P.
October 7.—D and L went to Paris. Clear G and P.
October 8.—B arrived at Greenwich. Clear G: raining P.
October 9.—Clear G: raining P.
October 10.—Cloudy P and G.
October 11.—Quite clear P and G: two exchanges: full night.
October 12.—Cloudy P and G.
October 13.—Clear P and G: two exchanges: full night.
October 14.—Clear P and G: two exchanges: full night.
October 15.—Clear P and G: trouble with batteries G: one exchange: half night.

(End of 2nd Series.)

October 16.—Cloudy P and G.
October 17.—Clear P and G: two exchanges: full night.
October 18.—Cloudy G: clear P.
October 19.—Clear P and G: two exchanges: full night.
October 20.—Clear G: only partly P: half night.
October 21.—Clear P and G: two exchanges: full night.

(End of 3rd Series.)

October 22.—B and H T went to Paris.
October 23.—D and L went to Greenwich: clear P: only partly G: half night.
October 24.—Cloudy P and G.
October 25.—Cloudy P and G.
October 26.—Cloudy P and G.
October 27.—Clear P and G: two exchanges: full night.
October 28.—Raining G: partly clear P.
October 29.—Raining G: partly clear P.
October 30.—Partly clear: one exchange: half night.
November 1.—Cloudy P and G.
November 2.—Cloudy P and G.
November 3.—Cloudy P and G.
November 4.—Cloudy P and G.
November 5.—Cloudy P and G.
November 6.—Cloudy P: clear G.
November 7.—Cloudy P and G.
November 8.—Cloudy P and G.
November 9.—Partly clear: one exchange: half night.
November 10.—Cloudy P and G.
November 11.—Cloudy P and G.
November 12.—Cloudy G: clear P.
November 13.—Clear P and G: two exchanges: full night.

(End of 4th Series.)

It was decided that the English observations and the French should be worked up and published separately; and the following account is chiefly confined to the English observations.

Instruments used, etc.

Transits B (at Paris) and C (at Greenwich) of the series used in Transit of *Venus* 1874. Clear aperture $3\frac{1}{2}$ inches, focal length $36\frac{1}{2}$ inches. The pivots were re-turned before the operations and found sensibly circular, and equal.

Clocks.

At Paris, Breguet No. 2, placed in the observing-room and subjected to considerable fluctuations of temperature.

At Greenwich, the Sidereal Standard, through the medium of two relays.

Instrumental Constants, etc.

Considerable labour was requisite to obtain a satisfactory determination of the values of the striding-level scales, which were found to be by no means uniform. A careful calibration, however, reduced the limits of possible error to very small amounts. The value of $1^{div.}$ ranged from $0''{\cdot}73$ to $1''{\cdot}35$ for the level of Transit B, and from $0''{\cdot}92$ to $1''{\cdot}57$ for that of Transit C.

Chronographs, etc.

The chronographs and the other automatic apparatus were of the pattern fully described in the "Mémorial du Dépôt Général de la Guerre," Tome XI., Section A, p. 20.

Instrumental Errors.

The collimation-error was determined both by reflexion observations from mercury and from observations of the same polar star in reversed positions of the instrument. No sensible systematic difference was found between the two methods for either instrument. [The actual mean systematic differences found for Transits B and C were $+ 0''{\cdot}03$ and $- 0''{\cdot}15$ respectively.] Some considerable trouble was caused at the beginning of the operations by the object-glasses almost simultaneously becoming loose in their cells. Trial observations with the instruments had been quite satisfactory. Fortunately, the discovery was made, and the defect remedied, before any actual longitude work had been done. Messrs. Troughton & Simms, to whom the instruments had previously been sent for examination, are unable to account for the occurrence.

The level error was determined both by reflexion observations and by the striding level. The systematic differences between the two methods were found to be $- 0''{\cdot}13$ and $- 0''{\cdot}28$ for B and C respectively.

The azimuth-error was determined by observation of one or more of 12 polar stars culminating between $19\frac{1}{2}^h$ and $3\frac{1}{4}^h$ sidereal time. It may be remarked that only one of the more frequently observed stars was observed at lower culmination: so that only 46 transits out of 262 were sub-polar. But though this may have some bearing on the absolute clock-errors at the two stations, it does not affect the longitude, the same stars (nearly) being observed at both stations. The places of the polar stars were adopted from recent Greenwich transit-circle observations.

Stars for Clock-error.

The stars were selected from a previously arranged catalogue, and the places adopted were corrected by means of the observations themselves, according to the method explained in the paper in "Mém. Gén. du Dép. de la Guerre" cited above. The mean of the corrections to ephemeris indicated by the results of all four observers was adopted for use.

Clock-rate.

The operations were arranged so that the mean epoch of the signals was as nearly as possible the same as the mean epoch of the star-transits on each night, and thus if the clock-rate be uniform during the operations on each evening, its magnitude has no sensible influence on the result for longitude. Moreover, the rate of the Greenwich clock was very small throughout, never reaching $0^s.2$ per day. But it was found that the rate of the clock used at Paris, which was subjected to considerable variations of temperature, was sensibly different at different times of the day. For the present investigation, the rate was assumed uniform for the period of observation on each night, and was determined independently by the English and French observers from comparison of the later star-transits with the earlier. The mean of their results was adopted for use; but the experience gained suggests the advisability of using a more carefully protected clock for longitude operations; for it is not at all clear that the assumption of a uniform rate from sunset to midnight (the usual period of observation for longitude work) for a clock known to have a diurnal inequality, is justifiable; and the above method of eliminating clock-rate by making coincident the mean epochs of signals and time-determination is not only sometimes difficult in practice, but is based entirely on this assumption of uniformity of rate.

Signals.

The exchanges of signals were made automatically, and the pairs of chronographs at each end were combined in the three possible different ways. The differences between different sets ranged over nearly $0^s.10$, this quantity being made up of errors resulting from changes in the state of the cable, in clock-rate, and others more or less accidental. As regards changes in the cable it may be remarked that the apparent time of transmission of the current deduced from comparison of signals sent in opposite directions, ranged from zero to $0^s.085$ for single sets of signals (40 each way in each set); or, if we compare the mean of different evenings, from $0^s.021$ to $0^s.067$.

Results for Longitude.

A preliminary discussion of the observations of the English and French observers, who made their computations independently, showed a considerable difference—about $0^s.4$—between their results for longitude. Such a large quantity as this was at first attributed to some mistake in computation, and all the figures were subjected to a careful scrutiny. But although one or two small matters were noticed which would diminish this difference (the discussion of which, however, belonged more properly to the final reduction), no serious mistake was discovered. It was then arranged that Commt. Defforges should visit Greenwich, bringing with him the French reductions, to discuss the discre-

pancy in concert with the English observers. This visit was paid in June, 1890. Another thorough examination of the reductions was made without result, but the discrepancy was localised in the time-determinations at Greenwich, where the English and French results were found to differ by a much larger quantity than the known difference of personal equations of the observers would explain. On further inquiry it was found that the results for level-error of the French instrument as obtained with the striding level differed systematically by 3″ from those obtained by reflexion observations from mercury. Only a few of the latter had unfortunately been made, but there could be no doubt about the discrepancy, which was confirmed in every case throughout the observations. The only difficulty was to explain this discrepancy on any assumption of instrumental defect. No satisfactory assumption has yet been thought of; but the fact remains that if the nadir observations were considered correct, and the striding-level observations consequently erroneous by the amount indicated, the French time-determinations would be brought into excellent accord with the English. In the absence of any direct confirmation of this view, however, the French observers did not feel justified in making this assumption; they decided rather to take the mean between the discrepant determinations of level-error; and consequently their results still differ from those of the English observers by half the amount in question—viz. about $0^s{\cdot}16$.

In the final discussion of the results there arises the question what weight shall be given to different nights. It is usual in such cases to make an elaborate determination of probable error for the various elements, and form weights accordingly; but in the present case a procedure was adopted which throws some light on the practical utility of such investigations—viz. various extreme suppositions were made in different directions, such as (1) that each evening should have equal weight whatever the number of observations; (2) that the weight should be directly proportional to the number of exchanges of signals, or (3) to the number of star-transits observed, &c. The first of these suppositions undoubtedly gives too much weight to the more unsatisfactory nights when little was done, and the second and third too much to the more complete nights. The truth should lie between them. But it was found that the results for longitude were practically the same on any of these suppositions, the whole range in such results being barely $0^s\,01$, and the mean of all is thus practically definitive. The following is the series of results obtained on eight of these different suppositions from the English observations:—

m	s	m	s
9	20·598	9	20·611
	·593		·599
	·594		·603
	·595		·605

It was thus not considered necessary to proceed further with the discussion of weights.

The final result for difference of longitude between the two instruments used by the English observers is $9^m\ 20^s{\cdot}60$, which, reduced to the meridian of Cassini and the Greenwich transit-circle, is

$$9^m\ 20^s\,85.*$$

The French reductions are practically complete, and their result will be $9^m\ 21^s{\cdot}04$ within a very small quantity. If the full correction to level indicated by nadir observations were adopted, this would be about $9^m\ 20^s{\cdot}88$, agreeing well with the English determination.

It may be remarked that the continuity of observations for time at Greenwich with the transit-circle, and with the same clock as was used by the longitude observers, affords a means of deducing the longitude from the observations of each observer independently. Thus the observations he made at Greenwich, when compared with those of the transit-circle, give his personal equation referred to the standard observer. On crossing to Paris, his time-determination can thus be directly compared, by means of the signals, with that made at Greenwich with the transit-circle. The results obtained in this manner would be as follows:—

	m	s
B	9	20·94
D		21·14
H T		20·83
L		20·87

It is to be remarked that the systematic correction to level-error from nadir observations was applied to the observations of B and D alike, although B did not make any nadir determinations. This may account for the discrepancy between their results.

* Transit C was 19 feet, or $0^s{\cdot}02$ W. of the Greenwich Transit-Circle; and Transit B was 12 feet, or $0^s{\cdot}01$ E. of the Montsouris meridian, which is $0^s{\cdot}29$ W. of the meridian of Cassini.

A List of Published Lunar Sketches and Photographs arranged according to the Sun's Position. By A. Marth.

In a paper published in vol. xlviii. of the *Monthly Notices*, containing my ephemeris for physical observations of the Moon for the nine lunations from the middle of April to the end of 1888, I mentioned that I intended to examine all the lunar sketches in the library of the Royal Astronomical Society, and to prepare a properly-arranged list of those which deserve not to be left out, and which are at least approximately timed. The times required for the purpose are obviously the times when the outlines of the shadow are drawn. If these are properly recorded, it is easy, with the help of similar ephemerides and of some data in the list of sketches, to find (to about a minute) the corresponding times in other lunations, when the sun reaches the same zenith-distances at the sketched objects, and thus to connect the phenomena, in whatever lunation they may have been observed. If, instead of these times of drawing the shadows, only vague indications are given that the sketches have been made between such and such hours, the evidence supplied by the drawings is affected by a corresponding vagueness and weakened accordingly. An obvious difficulty arises, if the required times are not attached to the sketches themselves, but have to be searched for through pages of text, when they may perhaps be found mentioned merely by the way as apparently unimportant, or also may be searched for quite in vain. Some series of sketches have also to be disregarded, till it shall please the sketchers to state what times are those which they give.

The strangest fact, however, is, perhaps, that in the library of the Royal Astronomical Society there is a considerable number of lunar photographs, and that a number have also been published, without the slightest indication of the times when they were taken. The greater part of the valuable evidence which these photographs might furnish for the advance of selenography is thus practically lost. How is such unworkmanlike thoughtlessness to be accounted for?

Under the circumstances I give now only a portion of the intended general list of published sketches and photographs.

The first column, headed "Sun's Colongitude," and containing two terms, supplies, for any value of the Sun's selenographical latitude, the colongitude which the Sun must reach in order to be at the same altitude above the horizon of the sketched spot as at the assigned time of the sketch. By reference to the ephemeris the corresponding time may thus be found to about a minute.

Then follow the Sun's colongitude and latitude at the time of the sketch or photograph, the name of the spot, the assigned

time, the name of the sketcher and the references to the publications where the published sketches are to be found. The abbreviations employed are :—

E. M.: "English Mechanic." Vol. and page.
L'Astr.: Flammarion's publication, "L'Astronomie." Year and page.
L. S.: "Liverpool Astronomical Society Journal." Vol.
S. J.: The "Selenographical Journal." Vol.
Sir.: Klein's publication, "Sirius." Year.

Bianchini's sketch of Plato, made 1725 Aug. 16, one-and-a-half-hour after sunset at Rome, was originally published in "Hesperi et Phosphori nova phænomena," 1728, and has since been repeatedly reproduced.

Schmidt's sketches of Hyginus are to be found in "Sir." 1882.

Stuyvaert's 50 "Dessins de la Lune," in vols. 4 and 5 of the "Annales de l'Observ. R. de Bruxelles." For convenience the sketches are here numbered, 1–16 and 17–32 being those on two plates in vol. 4, and 33–50 in vol. 5.

Trouvelot's 15 sketches are to be found on plates 4, 15, 18, 20 in vol. 8 of the "Annals of the Astron. Observatory of Harvard College."

Weinek's sketches are in "Astron. Beobachtungen . . zu Prag im Jahre 1884, enthaltend Originalzeichnungen des Mondes," and in a second publication with a similar title containing the sketches made in the years 1885–87. The numbers attached are those on the published plates, so that the year must decide the volume. The times assigned are those of the beginning and ending of the sketching, it being stated that, with one exception, the middle time is to be considered as that of the shadows. But as the times are given in quarter-hours, inconvenient to print, they are left out in the list.

The meridians to which the assigned times refer are: Ath., Athens; Br., Brussels; C., Cambridge, Massachusetts; Gr., Greenwich, Pr., Prague.

Sun's Colongitude.		Sun's Colong. Lat.	Spot.	Assigned Time. References.
306°·59 − 0·508	⊙'s lat.	306°·40 + 0°·38	Cleomedes	1888, Jan. 16, about 6h Gr. A. Mee, E.M. 46, 50
310·40 − 0·686	,,	310 00 + 0·58	Bernoulli	1883, Apr. 10, 3h 50m Br. Stuyvaert, 46.
320·73 + 0·162	,,	320·81 + 0·48	Guttenberg	1881, Jan. 4, 6h 0m Br. Stuyvaert, 34.
321·59 + 0·162	,,	321·74 + 0·92	,,	1872, July 9, 9h 0m C. Trouvelot, pl. 15.
		326·78 + 0·75	Atlas, Hercules	1882, Apr. 22, 7h·5–9h·5 Gr. Elger, S.J. 5.
326·81 + 0·412	,,	327·11 + 0·72	Fracastor	1886, Feb. 8, 6–7h. Goodacre, E.M. 42, 513.
329 61 + 0·036	,,	329·61 + 0·33	Messier	1884, Mar. 31, 8h 15m Br. Stuyvaert, 49.
331·76 − 0·615	,,	332·10 − 0·55	Posidonius	1879, Dec. 18, 5h 30m Br. ,, 5.
333·61 + 0·075	,,	333·50 − 1·52	Torricelli	1872, Mar. 14, 9h 30m C. Trouvelot, pl. 4.
336·09 + 0·077	,,	336·20 + 1·47	,,	1880, Mar. 16, 8h 20m Br. Stuyvaert, 7.
338·46 − 0·274	,,	338·07 + 1·41	Plinius	1885, Jan. 21, 5h 30m Gr. Elger, L.S. 5.
339·83 − 1·122	,,	341·07 − 1·12	Hercules	1887, June 26, ab. 8h 30m. A. Mee, E.M. 45, 437.
340·02 + 0·086	,,	340·04 + 0·23	Hypatia	1872, June 11, 10h 0m C. Trouvelot, pl. 15.
341·22 + 0·625	,,	341·41 + 0·31	Zagut...Lindenau	1884, Apr. 1. Weinek, 9.
341·72 − 0·274	,,	342·01 − 1·05	Plinius	1873, Jan. 4, 6h 0m C. Trouvelot, pl. 18.
343·68 − 0·631	,,	344·01 − 0·52	Posidonius	1879, Dec. 19, 5h 0m Br. Stuyvaert, 6.
345·29 − 0·155	,,	345·54 − 1·52	Julius Cæsar	1872, Mar. 15, 9h 0m C. Trouvelot, pl. 15.
346·05 − 0·277	,,	345·69 + 1·31	Plinius	1882, Jan. 25, 5–6h Gr. Elger, E.M. 50, 280.
346·73 − 1·195	,,	347·99 − 1·05	Aristoteles	1880, Nov. 8, 6h 45m Br. Stuyvaert, 8.
348·19 − 3·098	,,	346·54 + 0·53	Meton	1881, Jan. 6, 8h 45m Br. ,, 36.

Sun's Colongitude.	Sun's Colong.	Sun's Lat.	Spot.	Assigned Time. References.
348°·86 − 0·088 ⊙'s lat.	348°·73	+ 1°·48	Ariadaeus	1880, Mar. 17, 9h 0m Br. Stuyvaert, 9.
	350·84	− 1·52	phot.	1890, Mar. 27, 8h Paris. Henry.
351·59 − 0·528 ,,	352·37	− 1·47	Linné	1873, Mar. 5, 7h 0m C. Trouvelot, pl. 20.
351·89 − 0·283 ,,	352·15	− 0·91	Plinius	1890, Jan. 27, 7h Gr. T.S.S., E.M. 50, 528.
353·44 − 0·141 ,,	353·53	− 0·63	Hyginus	1881, July 3, 7h·7 Ath. Schmidt.
353·62 − 0·141 ,,	353·78	− 1·48	,,	1880, Oct. 10, 6h·0 Ath. ,,
354·51 − 0·141 ,,	354·31	+ 1·41	,,	1879, Mar. 29, ab. 11h Gr. Green, Neison, S.J. 2.
354·52 − 0·141 ,,	354·39	+ 0·89	,,	1881, May 5, 7h·2 Ath. Schmidt.
354·80 − 0·141 ,,	354·59	+ 1·52	,,	1881, Mar. 7, 6h·4 Ath. ,, S.J. 5.
355·13 − 0·141 ,,	355·08	+ 0·36	,,	1880, June 14, 9h 10m Br. Stuyvaert, 12.
355·64 − 0·141 ,,	355·76	− 0·88	,,	1881, Oct. 29, 6h 30m Br. ,, 44.
355·80 − 0·141 ,,	356·02	− 1·53	,,	1881, Aug. 31, 7h·0 Ath. Schmidt.
356·54 + 0·201 ,,	356·82	+ 1·40	Albategnius	1886, Nov. 3. Weinek, 18.
356·66 − 0·141 ,,	356·85	− 1·33	Hyginus	1878, Oct. 3, 5h·6 Ath. Schmidt.
356·72 − 0·141 ,,	356·73	− 0·05	,,	1878, Feb. 9, 5h·7 Ath. ,,
356·78 + 0·072 ,,	356·82	+ 1·40	Hipparchus	1886, Nov. 3. Weinek, 18.
356·95 − 0·141 ,,	357·02	− 0·49	Hyginus	1879, Dec. 20, 6h 40m Br. Stuyvaert, 13.
356·99 − 0·141 ,,	356·86	+ 0·96	,,	1877, July 17, 9h.5 Ath. Schmidt.
357·11 − 0·072 ,,	357·22	− 1·52	Agrippa	1872, Mar. 16, 8h 0m C. Trouvelot, pl. 4.
357·15 − 0·047 ,,	,,	,,	Godin	,, ,, ,, ,,

Sun's Colongitude.		Sun's Colong.	Lat.	Spot.	Assigned Time. References.
°		°	°		
357·46 − 0·141	⊙'s lat.	357·28	+ 1·30	Hyginus	1882, Mar. 26, 8^h Gr. Green, S.J. 5.
357·54 − 0·141	,,	357·53	− 0·09	,,	1882, May 24, 8^h 30^m. McCance, S.J. 5.
357·66 − 0·141	,,	357·66	+ 0·02	,,	1878, Aug. 5, $7^h{\cdot}5$ Ath. Schmidt.
358·20 − 0·141	,,	358·02	+ 1·30	,,	1882, Mar. 26, 9^h 10^m–9^h 45^m Gr. Neison, S.J. 5.
358·23 − 0·141	,,	358·10	+ 0·92	,,	1879, Feb. 28, $6^h{\cdot}7$ Ath. Schmidt.
358·30 + 0·201	,,	358·20	− 0·49	Hipp., Albategnius	1879. Dec. 20, 9^h 0^m Br. Stuyvaert, 15.
358·47 − 0·141	,,	358·62	− 1·04	Hyginus	1880, Nov. 9, $5^h{\cdot}0$ Ath. Schmidt.
359·23 − 0·852	,,	358·83	+ 0·47	Cassini	1887, Jan. 31. Weinek, 19.
0·19 − 0·141	,,	359·97	+ 1·52	Hyginus	1879, Apr. 28, ab. $10^h{\cdot}5$ Gr. Green, S.J. 2.
0·46 − 0·142	,,	0·67	− 1·49	,,	1880, Sept. 11, $7^h{\cdot}0$ Ath. Schmidt.
0·70 − 0·142	,,	0·55	− 1·05	,,	1880, May 16, 8^h 30^m Gr. Green, S.J. 5.
0·78 − 0·142	,,	0·73	+ 0·36	,,	1880, Jan. 19, 4^h 20^m Gr. Rand Capron, S.J. 4.
0·95 − 0·142	,,	0·73	+ 1·52	,,	1879, Apr. 28, 12^h Gr. Neison, S.J. 2.
1·57 − 0·142	,,	1·77	− 1·38	,,	1881, Sept. 30, $6^h{\cdot}5$ Ath. Schmidt.
1·93 − 0·142	,,	1·72	+ 1·49	,,	1880, Mar. 18, 10^h 35^m Br. Stuyvaert, 14.
2·04 + 0·047	,,	2·11	+ 1·40	Réaumur	1881, Apr. 6, 9^h 0^m Br. ,, 40.
2·24 + 0·589	,,	1·35	− 1·51	Walter, Aliac., Werner	1884, June 30. Weinek, 13.
2·27 − 0·142	,,	2·49	− 1·54	Hyginus	1878, Nov. 2, $6^h{\cdot}0$ Ath. Schmidt.
3·11 + 0·151	,,	3·21	+ 0·66	Ptolemæus	1886, Feb. 11. Weinek, 10.
3·29 − 1·143	,,	3·18	+ 0·76	Hyginus	1878, July 7, $7^h{\cdot}4$ Ath. Schmidt.

Sun's Colongitude.	Sun's Colong. Lat.	Spot.	Assigned Time. References.
3°·34 − 0·858 ⊙'s lat.	2°·06 + 1·49	Cassini	1880, Mar. 18, 11h 15m Br. Stuyvaert, 17.
	4·54 − 1·52	photo.	1890, Mar. 28, 9h Paris. Henry.
5·47 − 0·870 ,,	4·46 + 1·16	Cassini	1872, Oct. 9, 8h 0m C. Trouvelot, pl. 18.
6·05 − 1·047 ,,	6·31 − 0·25	Eudoxus	1877, Feb. 20, 10h C. ,, L'Ast. 85, 213.
6·39 − 1·620 ,,	5·97 + 0·26	Atlas	1884, Apr. 3, 7h 30m Gr. Elger, L.S. 2.
6·52 − 0·566 ,,	6·37 + 0·26	Archimedes	1884, Apr. 3. Weinek, 10; L'Ast. 87, 401.
6·84 + 0·231 ,,	6·58 − 1·09	Alphons, Alpetragius	1873, Jan. 6, 6h 30m C. Trouvelot, pl. 18.
6·94 + 0·328 ,,	,, ,,	Arzachel	,, ,, ,,
7·85 − 0·146 ,,	8·07 − 1·53	Hyginus	1881, Sept. 1, 6h·7 Ath. Schmidt.
8·02 − 0·320 ,,	7·81 + 0·67	Plinius	1889, Nov. 30, 8h 30m–9h Gr. Maw., E.M. 50, 340.
8·20 − 0·567 ,,	7·58 + 1·10	Archimedes	1880, Feb. 18, 8h 30m Br. Stuyvaert, 18.
8·30 − 0·156 ,,	8·17 + 0·86	Ukert	1881, May 6, 9h 0m Br. Stuyvaert, 41.
9·48 − 0·146 ,,	9·29 + 1·32	Hyginus	1878, June 8, 8h·5 Ath. Schmidt.
9·85 − 0·146 ,,	9·87 − 0·11	,,	1882, May 25, 8h 45m Gr. McCance, S.J. 5.
10·37 + 0·406 ,,	10·98 + 1·51	Wall near Thebit	1883, Feb. 15, 6h 30m. Elger, L.S. 5; E.M. 38, 496.
10·63 − 0·330 ,,	10·19 + 1·35	Plinius	1882, Jan. 27, 5h 30m–6h 15m. Elger, E.M. 50, 280.
10·69 − 0·147 ,,	10·76 − 0·47	Hyginus	1879, Dec. 21, 9h 30m Gr. Pratt, Sir. 80.
11·25 − 1·204 ,,	9·53 + 1·43	Plato	1725, Aug. 16. Bianchini. L'Ast. 87, 447.
11·80 − 1·018 ,,	11·34 + 0·45	Pico	1887, Feb. 1, 6h 0m Gr. Elger, L.S. 4; E.M. 44, 56
11·87 − 1·205 ,,	,, ,	Plato	,, ,, ,, ,, L'Ast. 87, 210

Sun's Colongitude.		Sun's Colong. Lat.	Spot.	Assigned Time. References.
12°·39 + 0·234	⊙'s lat.	12°·62 + 0°·99	Alphons	1884, Mar. 5, 7^h 30^m. Elger, E.M. 39, 50.
13·51 + 0·182	,,	13·58 + 0·39	Guerike	1880, Jan. 20, 6^h 0^m Br. Stuyvaert, 19.
14·76 − 0·258	,,	14·50 + 1·01	Eratosthenes	1887, Dec. 23. Weinek, 23
		15·05 + 1·23	photo.	1877, Apr. 21, ab. 10^h Gr. Common, S.J. 3.
15·06 − 0·176	,,	15·23 − 0·94	Stadius	1886, Apr. 12, 8^h 0^m Gr. Elger, E.M. 43, 214.
		15·14 + 0·39	photo.	1880, Jan. 20, 8^h 47^m Gr. Common.
15·34 − 0·258	,,	15·64 − 1·15	Eratosthenes	1872, Apr. 16, 9^h 0^m C. Trouvelot, pl. 4.
		16·21 + 1·51	photo.	1890, Mar. 29, 8^h Paris. Henry.
15·44 − 1·214	,,	17·22 − 1·46	Plato	1873, Mar. 7, 8^h 0^m C. Trouvelot, pl. 20.
15·72 − 1·023	,,	,, ,,	Pico	,, ,, ,,
17·25 + 0·182	,,	17·18 − 0·40	Guerike, Parry	1887, Mar. 3, 7^h 30^m Gr. Elger, L.S. 6.
18·09 + 0·934	,,	18·30 + 0·23	Tycho	1884, Apr. 4. Weinek, 11.
18·82 + 0·073	,,	18·73 − 1·12	Fra Mauro	1873, Jan. 7, 6^h 30^m C. Trouvelot, pl. 18.
18·93 + 0·182	,,	,, ,,	Guerike, Parry	,, ,, ,,
19·43 + 0·141	,,	19·40 − 0·24	Bonpland	1880, Dec. 10, 6^h 0^m Br. Stuyvaert, 20.
20·78 − 0·473	,,	20·38 + 0·84	Lambert	1881, May 7, 9^h 0^m Br. Stuyvaert, 42.
22·37 + 1·571	,,	22·70 + 0·21	Clavius	1886, Sept. 7. Weinek, 17.
24·72 + 0·546	,,	24·71 − 0·02	Kies	1881, Nov. 20, 5^h 15^m Br. Stuyvaert, 45.
25·59 − 0·165	,,	25·84 − 1·52	Copernicus	1884, July 2. Weinek, 14
		25·86 − 0·42	,,	1876, Apr. 6, 9^h–11^h Gr. Brett, Obs. 1.

Sun's Colong. minus ☉'s lat.	Sun's Colong.	Lat.	Spot.	Assigned Time. References
26°·17 + 0°·294	25°·77	− 1°·37	Lubiniezki	18°9, Mar. 11, ab. 7^h. G. T. Davis, E.M. 49, 109.
	27·73	+ 1·37	Alpine Valley	1885, Jan. 25, $6^h·5$–$8^h·5$. Elger, L.S. 3; Sir. 85.
27·89 − 0·170	28·15	− 1·54	Hyginus	1878, Nov. 4, 7^h Gr. Lindsay and Copeland, M.N. 39.
28·98 + 0·523	28·68	− 0·57	Mersenius, Campanus	1886, Aug. 9, $8^h·5$ Prag. Weinek, 16.
29·07 + 0·682	,,	,,	Cichus, Capuanus	,, ,, ,,
29·57 − 0·174	29·84	− 1·54	Hyginus	1878, Nov. 4, 10^h 20^m. Lindsay and Copeland.
30·95 − 0·176	30·69	+ 1·45	Milichius	1880, Apr. 19, 8^h 20^m Br. Stuyvaert, 22.
31·43 − 0·106	31·28	+ 1·45	Hortensius	1880, Apr. 19, 9^h 30^m Br. Stuyvaert, 21.
31·61 − 0·057	31·60	+ 0·21	Reinhold	1884, Apr. 5, 9^h–11^h Gr. Elger, E.M. 39, 230.
32·03 + 0·126	31·85	− 1·43	Enclides, Riph.	1884, Aug. 1. Weinek, 16.
32·08 + 0·480	32·47	+ 0·82	Rills near Campanus	1881, May 8, 8^h 30^m Gr. Elger, L.S. 5.
33·72 + 0·481	34·32	+ 1·25	,, ,,	1882, Mar. 29, 9^h. Elger, L.S. 5.
35·51 + 0·465	35·70	+ 0·41	Hippalus	1883, Apr. 17, 9^h 25^m Br. Stuyvaert, 47.
35·72 + 0·329	36·22	+ 1·50	Agatharchides	1872, Sept. 12, 10^h 0^m C. Trouvelot, pl. 15.
	35·94	+ 0·80	Sinus Iridum	1888, Dec. 23, 8^h 10^m Gr. Elger, E.M. 48, 461.
	36·43	− 0·33	Newton, Short, Klaproth	1887, July 30. Weinek, 22.
36·72 − 1·343	36·17	+ 0·41	Condamine	1883, Apr. 17, 10^h 55^m Br. Stuyvaert, 48.
36·82 − 0·001	36·82	− 1·83	Landsberg	1878, Oct. 6, 11^h Gr. Noble, S.J. 1.
37·98 − 0·136	38·01	− 0·23	Kepler	1890, Jan. 1, 11^h. T. S. S., E. M. 50, 528.
	38·30	− 1·53	Sinus Iridum	1884, July 3. Weinek, 15; L'Ast. 87, 401.

Sun's Co\ongitude.	Sun's Colong. Lat.	Spot.	Assigned Time. References.
	38°·56 + 1°·36	Mare Humorum	1881, Apr. 9, 8h 30m Gr. Elger, L.S. 5.
38·61 − 0·578 ⊙'s lat.	37·81 + 1·37	Diophantus, Delisle	1885, Nov. 17. Weinek, 9.
39·63 − 0·578 ,,	39·61 + 0·03	,, ,,	1885, Sept. 19, 7h 30m Gr. Elger, L.S. 5
39·65 − 0·075 ,,	39·75 − 1·34	Encke	1885, July 22. Weinek, 8.
40·98 + 0·304 ,,	41·28 + 0·99	Gassendi	1886, Oct. 8, 8h 15m Gr. Elger, L.S. 5.
41·30 + 0·305 ,,	40·96 − 1·12	,,	1879, Nov. 24, 7h 0m Br. Stuyvaert, 23.
41·68 − 1·601 ,,	40·75 + 0·58	Horrebow	1886, Feb. 14. Weinek, 11.
41·85 + 0·532 ,,	42·53 + 1·28	Doppelmayer	1884, Nov. 28, 7h–8h. Elger, L.S. 5.
42·94 + 0·305 ,,	42·48 − 1·51	Gassendi	1887, May 3, 10h 30m–11h. J. Bone, E.M. 49, 368.
43·18 + 0·305 ,,	43·23 + 0·18	,,	1884, Apr. 6. Weinek, 12; L'Ast. 87, 401.
	43·54 + 1·28	Alpine Valley	1884, Nov. 28, 9h–10h Gr. Goodacre, E.M. 40, 319.
44·18 − 0·138 ,,	44·37 − 1·42	Kepler	1884, Aug. 2. Weinek, 17; L'Ast. 87, 401.
44·16 − 0·076 ,,	,, ,,	Encke	,, ,, ,,
45·48 − 0·433 ,,	45·16 + 0·75	Aristarchus	1885, Feb. 25. Weinek, 3.
49·04 + 0·309 ,,	48·57 − 1·53	Gassendi	1873, Feb. 8, 8h 0m C. Trouvelot, pl. 20.
	49·08 − 0·40	Clefts near Mersenius	1883, Oct. 12, 7h–10h Gr. Elger, E.M. 38, 171.
49·78 + 0·384 ,,	50·36 + 1·52	Mersenius	1880, Mar. 22, 10h 30m Br. Stuyvaert, 25.
49·84 + 0·309 ,,	50·30 + 1·48	Gassendi	1886, Dec. 7, 5h 40m Gr. Elger, L.S. 5.
49·89 − 0·431 ,,	49·49 + 0·92	Aristarchus, Herodotus	1884, Mar. 8, 7h 30m–9h 0m. Elger, L.S. 3.
50·07 + 0·079 ,,	50·19 + 1·52	Flamsteed	1880, Mar. 22, 10h 10m Br. Stuyvaert, 24.
50·66 − 0·585 ,,	50·12 + 0·92	Wollaston	1884, Mar 8, 9h–10h Gr. Elger, E.M. 39, 485.

Sun's Colongitude.	Sun's Colong.	Lat.	Spot.	Assigned Time. References.
51°·91 + 0°·385 ⊙'s lat.	51°·56	− 0°·92	Mersenius	1884, Sept. 1, 10h. Elger, L.S. 5.
	52·38	+ 1·53	Arist., Herodotus	1884, Jan. 9, 8h–11h Gr. Elger, E.M. 38, 448.
53·79 − 0·433 ,,	54·00	− 0·49	,, ,,	1887, Mar. 6. Weinek, 20.
53·87 − 0·433 ,,	54·38	− 1·18	,, ,,	1873, Jan. 3, 5h 0m C. Trouvelot, pl. 20.
55·00 + 0·388 ,,	55·20	+ 0·51	Mersenius	1887, Aug. 30. Weinek, 23.
	58·49	− 0·29	Herodot Valley	1886, Mar. 17, 8h 30m Gr. Elger, L.S. 5.
61·88 + 0·255 ,,	62·27	+ 1·53	Sirsalis	1880, Mar. 23, 10h 0m Br. Stuyvaert, 28.
62·23 + 1·159 ,,	60·55	− 1·45	Wargentin	1887, June 3, 9h 45m Gr. A. Mee, E.M. 45, 366.
62·31 + 0·255 ,,	62·44	+ 0·51	Billy, Hansteen	1880, Jan. 24, 6h 35m Br. Stuyvaert, 26.
62·89 + 0·093 ,,	62·84	− 0·58	Damoiseau	1880, July 19, 9h 15m Br. Stuyvaert, 27.
64·12 + 0·978 ,,	63·25	− 0·89	Schickard	1884, Sept. 2, 9h Gr. Elger, E.M. 40, 280.
64·41 + 0·093 ,,	64·49	+ 0·91	Damoiseau	1887, Dec. 27, 8h–9h. Elger, E.M. 47, 280.
64·62 − 0·116 ,,	64·71	+ 0·09	Reiner	1885, Sept. 21, 9h. Elger, L.S. 5.
67·93 + 0·991 ,,	69·34	+ 1·42	Schickard	1880, Apr. 22, 12h 30m Br. Stuyvaert, 29.
	70·58	+ 0·72	photo.	1877, Mar. 27, ab. 11h Gr. Common, S.J. 3.
	71·47	+ 1·42	Plinius	1882, Feb. 1, 7h. Elger, E.M. 50, 280.
80·89 + 0·108 ,,	81·04	+ 1·41	Grimaldi	1880, Apr. 23, 11h 35m Br. Stuyvaert, 30.
	83·10	+ 1·03	Plato	1887, Jan. 8, 12h 30m–14h. Williams, E.M. 44, 499. L'Ast. 87, 211.
84·18 − 1·837 ,,	81·60	+ 1·41	Cleostratus	1880, Apr. 23, 12h 40m Br. Stuyvaert, 32.
	84·91	− 0·21	Moon Eclipsed	1887, Aug. 3, 8h 37m Prag. Weinek.
	85·93	− 0·21	,, ,,	,, ,, 10h 38m Prag. Weinek.
	88·99	+ 1·35	λ − 69°, β + 80°	1881, Feb. 7, 9h 40m Br. Stuyvaert, 31.

Sun's Colongitude.		Sun's Colong.	Sun's Lat.	Spot.	Assigned Time. References.
°		°	°		
		94·24	+ 1·49	photo.	1875, June 18, $16^h\ 9^m$ sid. t. Cordoba. Gould.
99·84	+ 0·751	⊙'s lat.		Gauss	1881, Feb. 14, $9^h\ 10^m$ Br. Stuyvaert, 37.
108·55	− 0·469	,,		Petavius	1890, Oct. 29, $9^h\ 12^m$ Gr. J. B., EM. 52, 334.
108·83	+ 0·330	,,		Hyginus	1878, Dec. 10, 12^h Gr. Lindsay and Copeland.
		112·53	− 0·69	Mare Crisium	1880, July 23, $11^h\ 0^m$ Br. Stuyvaert, 1.
113·49	+ 0·663	,,		Geminus	1885, Sept. 25, $9^h\ 30^m$ Gr. Elger, E.M. 42, 299.
113·74	+ 0·141	,,		Firmicus	1881, Feb. 15, $11^h\ 0^m$. Br. Stuyvaert, 35.
114·80	− 0·188	,,		Gutt., Goclenius	1890, Feb. 6, 10^h, ?Paris. Navarro, L'Ast. 90, 188.
118·18	+ 0·329	,,		Plinius	1889, Dec. 9, 11^h–$11^h\ 30^m$ Gr. Maw, E.M. 50, 340.
118·28	+ 0·757	,,		Messala	1883, Sept. 18, 11^h Gr. Elger, L.S. 6.
121·50	+ 0·508	,,		Cleomedes	1879, Dec. 30, $12^h\ 40^m$ Br. Stuyvaert, 3.
121·80	− 0·035	,,		Messier	1881, July 13, $14^h\ 15^m$ Br. Stuyvaert, 43; Sir. 84.
122·04	− 0·459	,,		Petavius	1886, June 18. Weinek, 16.
		125·58	+ 0·66	Mare Crisium	1880, Jan. 29, $11^h\ 30^m$ Br. Stuyvaert, 2.
		125·83	+ 0·76	,, ,,	1884, Mar. 14. Weinek, 5.
125·88	− 1·621	,,		Hagecius	1885, Apr. 2. Weinek, 4.
125·94	− 1·399	,,		Biela, Rosenberger	,, ,, ,, ,,
		126·00	+ 0·66	Mare Fœcunditatis	1880, Jan. 29, $12^h\ 20^m$ Br. Stuyvaert, 4.
126·04	+ 0·100	,,		Taruntius	1885, Sept. 26, 10^h Gr. Elger, L.S. 5.
127·98	− 0·035	,,		Messier	1881, Feb. 16, $14^h\ 40^m$ Br. Stuyvaert, 38; Sir. 84.
130·69	+ 0·377	,,		Macrobius	1887, July 8. Weinek, 21.

Sun's Colongitude.	Sun's Colong.	Sun's Lat.	Spot.	Assigned Time. References.
132°·18 − 0·241 ⊙'s lat.	132°·50	− 1°·32	Colombo, Magelhaens	1884, Aug. 9. Weinek, 18.
132·20 − 0·607 ,,	133·12	− 1·52	Neander	1886, May 21. ,, 14.
133·20 − 0·427 ,,	133·38	− 0·44	Fracastor B.	1889, June 16, ab. 15^{h} Gr. J. M. Bacon, E.M. 49, 414.
134·16 − 0·908 ,,	134·60	− 0·49	Fabricius, Metius	1886, Mar. 23. Weinek, 12.
134·90 + 2·251 ,,	135·97	+ 0·48	Plato	1886, Sept. 16, 14^{h} 30^{m} Gr. Williams, E.M. 44, 151.
135·96 + 0·258 ,,	135·76	− 0·76	Jansen	1880, Nov. 20, 11^{h} 15^{m} Br. Stuyvaert, 33.
137·47 + 1·052 ,,	138·24	+ 0·73	Hercules	1884, Mar. 15. Weinek, 6.
138·60 − 0·905 ,,	138·86	− 0·29	Fabricius	1885, Apr. 3. ,, 5.
139·74 + 0·178 ,,	139·99	+ 1·42	Cauchy (Jansen A.)	1881, Feb. 17, 14^{h} 30^{m} Br. Stuyvaert, 39.
141·52 − 0·408 ,,	141·89	− 0·91	Fracastor	1883, Sept. 20, 11^{h} Gr. Elger, L.S. 5; E.M. 38, 239.
142·45 + 0·282 ,,	142·55	+ 0·35	Plinius	1889, Dec. 9, 10^{h} 30^{m}–11^{h} 50^{m}. Maw, E.M. 50, 340.
142·49 − 1·202 ,,	144·05	− 1·30	Hommel, Pitiscus	1884, Aug. 10, 12^{h} 40^{m} Gr. Elger, L.S. 7.
144·14 − 0·407 ,,	144·67	− 1·30	Fracastor	1884, Aug. 10. Weinek, 19; L'Ast., 87.
149·60 − 0·201 ,,	149·46	+ 0·70	Theoph., Cyrillus	1884, Mar. 16. ,, 7.
151·56 + 0·615 ,,	151·36	− 0·32	Posidonius	1885, Apr. 4. ,, 6.
153·76 + 0·274 ,,	153·96	+ 0·73	Plinius	1887, Sept. 4, 11^{h} 0^{m}. Elger, E.M. 46, 109.
153·76 + 0·201 ,,	153·52	+ 1·19	Cathar., Cyrillus	1885, Feb. 4. Weinek, 2.
153·91 − 0·326 ,,	,,	,,	Theophilus	,, ,,
158·42 − 0·954 ,,	158·50	− 0·08	Maurol., Barocius	1880, Jan. 2, 14^{h} 0^{m} Br. Stuyvaert, 10.
158·78 − 1·236 ,,	159·45	− 0·54	Bacon	1886, Mar. 25. Weinek, 13.
158·86 − 1·092 ,,	,,	,,	Clairaut, Barocius	,, ,,

Sun's Colongitude.	Sun's Colong. Lat.	Spot.	Assigned Time. References.
162°·31 + 0·072 ⊙'s lat.	162°·20 − 1°·54	Agrippa, Godin	1880, Sept. 24, 11^h 30^m Br. Stuyvaert, 11.
162·67 − 0·439 ,,	163·32 − 1·48	Sacrobosco	1885, June 3. Weinek, 7.
163·08 − 0·947 ,,	162·45 + 0·67	Maurolycus	1884, Mar. 17. ,, 8.
164·49 + 0·142 ,,	164·70 + 1·49	Hyginus	1878, May 22, 15^h. Ath. Schmidt, Sir. 82.
	167·78 − 0·85	Clefts nr. Bradley	1883, Sept. 22, 13^h–15^h Gr. Elger, E.M. 38, 106.
	168·12 − 1·27	Alpine Valley	1884, Aug. 12, 11^h. Elger, L.S. 3; E.M. 40, 33; Sir. 85.
171·59 + 0·141 ,,	171·38 − 1·49	Hyginus	1878, Oct. 17, 12^h 20^m. Lindsay and Copeland.
172·31 − 0·072 ,,	172·34 − 0·40	Triesnecker	1878, Aug. 19, 13^h 0^m–14^h 20^m. Neison, S.J. 1.
172 47 + 0·141 ,,	172·26 − 1·49	Hyginus	1878, Oct. 17, 13^h 40^m. Lindsay and Copeland.
172·66 − 0·201 ,,	172·94 − 1·40	Albategnius	1879, Nov. 5, 13^h 45^m Br. Stuyvaert, 16.
172·81 + 0·141 ,,	172·72 − 0·67	Hyginus	1880, Nov. 23, 13^h. Ath. Schmidt, Sir. 82.
173·07 + 0·141 ,,	172·86 − 1·49	,,	1878, Oct. 17, 15^h 15^m Gr. Lindsay and Copeland, M.N., 39.
173·24 ,, ,,	173·03 ,,	,,	,, 15^h 35^m ,, ,, ,,
173·62 ,, ,,	173·41 ,,	,,	,, 16^h 20^m ,, ,, ,,
173·96 ,, ,,	173·96 ,,	,,	,, 17^h ,, ,, ,,
186·94 − 0·932 ,,	185·53 + 1·51	Tycho	1885, Jan. 8. Weinek, 1.
187·17 + 1·230 ,,	187·13 − 0·03	Plato	1883, Oct. 23, ab. 17^h. Gemmil. E.M. 38, 239.
187·22 + 1·230 ,,	188·38 + 0·94	,,	1884, Nov. 10. Weinek, 20; L'Ast. 87, 403.
1 7·40 − 0·406 ,,	187·39 − 0·03	Wall nr. Thebit	1883, Oct. 23, 17^h 30^m. Elger, L.S. 5; E.M. 38, 496.
	209·44 + 0·83	photo.	1876, Apr. 18, 18^h 54^m sid. t. Cordoba. Gould.

Ephemeris for Physical Observations of the Moon. By A. Marth.
1891 February 12 to May 5.

Greenwich Noon. 1891.	Selenographical. Colong. of the Sun.	Lat. of the Sun.	Geocentric Libration. Sel. Long. of the Earth.	Lat. of the Earth.	Combined Amount.	Direction.
	°	°	°	°	°	°
Feb. 12	312·79	−1·45	+5·46	+5·70	7·88	316·4
13	324·98	1·46	6·66	4·69	8·14	305·3
14	337·16	1·47	7·36	3·45	8·12	295·2
15	349·33	−1·48	+7·59	+2·05	7·86	285·1
16	1·50	1·49	7·39	+0·58	7·42	274·5
17	13·66	1·50	6·85	−0·88	6·90	262·7
18	25·81	1·51	6·05	2·26	6·46	249·5
19	37·96	1·52	5·02	3·51	6·13	235·0
20	50·11	1·53	3·88	4·59	6·01	220·1
21	62·26	1·53	2·67	5·46	6·07	206·0
22	74·40	−1·54	+1·41	−6·08	6·24	193·0
23	86·54	1·54	+0·14	6·44	6·44	181·2
24	98·68	1·54	−1·12	6·51	6·61	170·3
25	110·82	1·55	2·37	6·31	6·70	159·4
26	122·97	1·55	3·58	5·82	6·83	148·5
27	135·12	1·55	4·72	5·08	6·93	137·2
28	147·27	1·54	5·77	4·09	7·07	125·5
Mar. 1	159·43	−1·54	−6·64	−2·90	7·25	113·7
2	171·59	1·54	7·34	1·56	7·50	102·0
3	183·76	1·53	7·73	−0·10	7·73	90·7
4	195·94	1·53	−7·75	+1·41	7·88	79·7
12	293·56	−1·49	+4·88	4·94	6·94	315·5
13	305·77	1·49	6·26	3·69	7·26	300·7
14	317·97	1·49	7·13	2·26	7·48	287·6
15	330·17	−1·48	+7·51	+0·74	7·54	275·6
16	342·36	1·48	7·41	−0·77	7·45	264·1
17	354·55	1·47	6·92	2·20	7·25	252·3
18	6·73	1·47	6·11	3·48	7·03	240·3
19	18·90	1·46	5·07	4·58	6·83	227·8
20	31·07	1·45	3·89	5·46	6·70	215·3
21	43·23	1·44	2·62	6·10	6·64	203·2
22	55·39	−1·43	1·33	−6·47	6·61	191·6
23	67·55	1·42	+0·05	6·56	6·56	180·4
24	79·71	1·41	−1·19	6·37	6·48	169·5
25	91·87	1·40	2·36	5·90	6·35	158·2

Greenwich Noon.	Selenographical. Colong. of the Sun.	Lat.	Geocentric Libration. Sel. Long. of the Earth.	Lat.	Combined Amount.	Direction.
1891.	°	°	°	°	°	°
Mar. 26	104·03	−1·38	−3·46	−5·15	6·20	146·2
27	116·19	1·37	4·46	4·17	6·10	133·2
28	128·35	1·35	5·34	2·98	6·11	119·2
29	140·51	−1·33	−6·07	1·63	6·28	105·1
30	152·68	1·32	6·61	−0·18	6·61	91·5
31	164·86	1·30	6·91	+1·32	7·03	79·2
Apr. 1	177·04	1·28	6·91	2·77	7·44	68·1
2	189·23	1·26	6·55	4·11	7·73	57·8
3	201·43	1·24	5·81	5·25	7·83	47·8
4	213·64	1·23	4·67	6·09	7·67	37·3
5	225·85	1·21	−3·18	6·57	7·29	25·7
11	299·20	−1·11	+6·24	+1·15	6·34	280·5
12	311·42	1·10	6·69	−0·44	6·71	266·2
13	323·64	1·08	6·70	1·96	6·98	253·6
14	335·85	1·07	6·31	3·34	7·14	242·0
15	348·06	1·05	5·59	4·52	7·18	230·9
16	0·26	1·03	4·61	5·46	7·15	220·1
17	12·45	1·01	3·46	6·15	7·06	209·3
18	24·64	0·99	2·21	6·57	6·93	198·5
19	36·83	−0·97	+0·93	−6·70	6·77	187·9
20	49·01	0·95	−0·33	6·55	6·56	177·1
21	61·19	0·92	1·52	6·11	6·30	166·1
22	73·36	0·90	2·60	5·39	5·99	154·3
23	85·53	0·87	3·55	4·42	5·67	141·3
24	97·70	0·85	4·35	3·23	5·41	126·7
25	109·88	0·82	4·98	1·86	5·31	110·5
26	122·06	−0·79	−5·42	−0·38	5·44	94·0
27	134·24	0·77	5·67	+1·15	5·78	78·5
28	146·42	0·74	5·69	2·64	6·27	65·0
29	158·61	0·71	5·47	4·02	6·78	53·6
30	170·81	0·69	4·98	5·19	7·19	43·7
May 1	183·01	0·66	4·23	6·09	7·41	34·7
2	195·22	0·63	3·22	6·63	7·37	25·8
3	207·44	0·61	1·99	6·77	7·05	16·3
4	219·67	0·59	−0·60	6·48	6·50	5·3
5	231·90	−0·56	+0·85	+5·77	5·83	351·6

Ephemeris of the Satellites of Uranus, 1891. By A. Marth.

Greenwich Noon. 1891.	P	*Ariel.* a_1	b_1	u_1-U	Diff.	*Umbriel.* a_2	b_2	u_2-U	Diff.
	°	"	"	°	°	"	"	°	°
Feb. 26	279·658	14·80	+10·37	37·62	1428·40	20·61	+14·45	251·45	868·68
Mar. 8	279·747	14·90	10·40	26·02	·36	20·76	14·49	40·13	·66
18	279·859	14·99	10·41	14·38	·33	20·89	14·50	188·79	·64
28	279·989	15·06	10·39	2·71	·30	20·98	14·48	337·43	·61
Apr. 7	280·131	15·11	10·35	351·01	·27	21·05	14·42	126·04	·60
17	·277	15·13	10·28	339·28	·24	21·08	14·32	274·64	·58
27	·421	15·12	10·20	327·52	·23	21·07	14·21	63·22	·58
May 7	·557	15·09	+10·10	315·75	·21	21·03	+14·06	211·80	·57
17	·681	15·04	9·99	303·96	·21	20·95	13·91	0·37	·57
27	·787	14·96	9·87	292·17	·20	20·84	13·75	148·94	·57
June 6	·871	14·86	9·76	280·37	·21	20·71	13·59	297·51	·58
16	·931	14·75	9·65	268·58	·21	20·55	13·44	86·09	·59
26	·965	14·63	9·54	256·79	·23	20·39	13·29	234·68	·61
July 6	·972	14·50	9·45	245·02	1428·24	20·21	13·16	29·29	868·62
16	280·952	14·37	+9·37	233·26		20·02	+13·06	171·91	

	Titania. a_3	b_3	u_3-U	Diff.	*Oberon.* a_4	b_4	u_4-U	U	B
	"	"	°	°	"	"	°	°	°
Feb. 26	33·81	+23·70	113·37	413·48	45·21	+31·69	43·71	358·499	+44·50
Mar. 8	34·05	23·77	166·85	·46	45·54	31·79	311·06	·563	44·27
18	34·26	23·79	220·31	·44	45·82	31·81	218·39	·644	43·97
28	34·42	23·75	273·75	·42	46·03	31·76	125·70	·737	43·62
Apr. 7	34·52	23·65	327·17	·42	46·17	31·62	33·00	·837	43·23
17	34·57	23·50	20·59	·41	46·23	31·42	300·30	358·940	42·82
27	34·56	23·30	74·00	·41	46·21	31·16	207·59	359·042	42·40
May 7	34·49	+23·07	127·41	·41	46·12	+30·85	114·88	·138	+41·99
17	34·36	22·82	180·82	·41	45·95	30·52	22·18	·224	41·61
27	34·18	22·56	234·23	·43	45·72	30·16	289·48	·297	41·28
June 6	33·97	22·29	287·66	·45	45·42	29·81	196·80	·355	41·01
16	33·71	22·04	341·11	·45	45·09	29·47	104·14	·395	40·81
26	33·44	21·80	34·56	·47	44·72	29·16	11·49	·416	40·69
July 6	33·14	21·59	88·03	413·49	44·32	28·88	278·86	·417	40·66
16	32·80	+21·42	141·52		43·92	+28·65	185·24	359·400	+40·71

The values of P, a, b, $u-\mathrm{U}$ are to be interpolated for the times for which the apparent positions of the satellites are required, and the position-angles p and distances s are then found by means of the formulæ:

$$s \sin (p-\mathrm{P}) = a \sin (u-\mathrm{U});$$
$$s \cos (p-\mathrm{P}) = b \cos (u-\mathrm{U}).$$

Titania and *Oberon* will appear in opposite directions from the centre of the planet:

h	h	h	h	h
Mar. 5 13·2	Mar. 30 4·5	Apr. 23 19·8	May 18 11·1	June 12 2·4

and in the same direction

h	h	h	h	h
Mar. 17 20·8	Apr. 11 12·1	May 6 3·4	May 30 18·8	June 24 10·1